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DWIGHT H. GREEN, *Governor*

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AFFILIATED WITH THE

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PRESIDENTIAL ADDRESS

MARK HOPKINS AND THE MODERN LOG

ERNEST L. STOVER
Eastern Illinois State College, Charleston

President Garfield once said that his idea of a college was Mark Hopkins on one end of a log and a student on the other. I do not know all that President Garfield had in mind when he made this often quoted statement but the complement presents the picture of a superior teacher, a person of scholarship, able to inform, direct, and inspire his pupil. The personality of such a teacher is characterized by charm, by enthusiasm for learning, by intuitive and intelligent skill in dealing with human beings. His special ability is to use knowledge to create interest, to make the hard task seem easy, and to use his understanding of people to bring about advantageous changes in character. The personifications of this ideal have built schools, departments of learning, and whole professions. The testimonials of their efficiency lie among traceable groups of professional men and in valued memories of untraceable individuals. There are not many who have represented this ideal, but wherever they have lived their influence has acted as a permanent leaven in the lives they have t o u c h e d, strengthened ambitions, and raised standards of achievement. The sphere of their influence has been over the nation and into new generations of students, but the center of that influence has been in the laboratory and classroom.

According to a recent bulletin from Mt. Holyoke College, Mark Hopkins had a brother who was a chemist, and he needed more than a log; he needed a laboratory. With the great teachers of the sciences, these workshops were places where the teacher himself progressed in the pursuit of knowledge, and the students knew, by precept and example, the momentum of the search for new truth and enthusiasm in its discovery. Fortunately for many of us there have been teachers—of less fame than Mark Hopkins, Agassii, Jordon, and Bessey—who have exerted these same influences in colleges and secondary schools. We can look back and say of some important directive force in our lives that it was the work of such a teacher; and our gratitude has been as fervent as it was often late in recognition.

Is it not for these qualities of leadership in the world of thought that the professional training of teachers is aiming, especially in the fields of the sciences where the goal is to influence habits of thinking and where the laboratory provides the "log" for informal and direct leadership, the ideal that emphasizes an independent but personal relationship? The creative result of that relationship must be the accepted ideal of those interested professionally in improving science teaching. Much has been written about what science teachers do not know, what combinations of courses they are teaching, what the organization of the courses they teach should be, what their objectives should be, what adults read (or have a chance to read) in the daily papers, what the "practical aspects" of science are that may improve man's physical condition and

give the tax-payer value received for the money spent for the teaching of the sciences. In the literature of science teaching there is apparent approval of the unification of subject matter as the correct principle of organization through the entire school system. In all of these objective and subjective philosophies there is almost nothing that emphasizes the particular requisites of science as a distinctive method of learning with a distinctive educational value resulting from that method.

Not stopping to discuss personal qualities, or the manual and visual skills needed in handling materials for classroom studies, what are the tools of the teachers of the sciences? The questions said to be asked in order of their incidence as the mind develops are: what is it, how does it work, and why does it do it? What, how, why—these are the grist to the mill of teaching; and in exactly that order the teachers of the sciences need certain bodies of knowledge from the various divisions of each of the fundamental sciences.

To answer the question, "What is it?" in the biological sciences, the teacher must know the main groups of plants and of animals, the names of individual kinds, and the characteristics by which they are identified at a glance. He finds it advantageous to know how the names came to be given and something of interest about the specimen, and particularly how to find out these facts if he does not know them. To achieve the ability to answer this one kind of question, about plants alone, he must have studied the taxonomy and gross morphology of the main groups, he must have practiced the use of keys and field identification until by patience and effort he has gained some degree of speed and sureness, and also has some idea of the value and usability of this type of information. To comprehend the time-cost of such ability it must be remembered that ferns, flowers, woody plants, birds, insects, fish and other aquatic life, each have separate techniques and vocabularies.

The fact that no one knows all this range of information does not invalidate the necessity of a fund of learning to answer just this one kind of question. It is this kind of knowledge that enables a teacher to make a walk through a well-known field a revealing experience to his students. Is it because the recognition of plants, animals, and rocks by name, is a dull or "impractical" kind of knowledge that such teaching has been left to Scout organizations, National Park naturalists talking to tourists, and other vacation activities?

The answers to the questions "how" and "why" are more commonly thought of in connection with science training. To answer questions concerning stages of events and their causes in studies in the biological sciences, the teacher must know the activities of plants and animals in specific relation to the structures concerned, and the processes in relation to the anatomy taking part in each process. Any disjunction of process and place of occurence prevents the formation of clear mental concepts that are the basis of usable knowledge. "Why" questions are often answered correctly by "I do not know," which may be the only intelligent and honest answer, but too often the lack of an answer is disguised by just words that seem to be an answer to the thoughtless, as in saying that plants grow toward the light because they need light. To provide real answers for this type of question requires experimental experiences in the laboratory and in the field. Causes and results of natural phenomena can only be explained to students by discipline in

both the fundamental and applied sciences for all natural phenomena involve a series of physical, chemical, and physiological changes.

Among the thoughtful leaders of professional teaching there is no tendency to minimize the necessity for a large amount of factual knowledge for the teacher, but there are those who favor (without objective evidence as to value) the generalized type of course to such a degree that the result is to reduce the amount of factual learning below a desirable minimum. This tendency has been partly a result of just criticism of the old "type" course in which the facts learned often had no connection with the daily phenomena of living. One of my friends told me that students in one of our universities were half through a semester course in botany before they realized they were studying plants.

The tendency toward generalized courses has also resulted from the discernment of the interdependence of one branch of science on knowledge from another. But whatever the cause of this move toward generalized courses involving more than one field of science, it has resulted in a philosophy of man's-interest-the-center-of-value in education; and as it has over-reached legitimate aims it has in turn divorced science and science teaching and placed real obstacles, I believe, in the way of achieving superior teaching in the sciences.

Mark Hopkins could get along with a log and his brother needed a laboratory, but the modern Hopkins needs much more than these things connote to the average mind.

Of first importance is the training of the individual teacher. This not only includes his training in a science and the related sciences but his training in how to organize and present the material to his classes. We have criticised the teachers colleges and colleges of education very severely on their over-emphasis on method of presenting material to classes, and they in turn have criticized the college and university science teachers for their laxity in trying to improve their methods of teaching. It is unfortunate that the professors of education have had so much to say without enough factual information and it is equally unfortunate that the teachers of the sciences have for the most part continued as they were taught and have not consistently tried to improve their teaching. There is an increasing number of science teachers who are attempting to conduct research in their teaching rather than to continue to wishfully think they are doing a good job of teaching. If you wish to see how bad some of the science courses are, just ask for the final examinations to see how little some teachers expect the students to know at the end of a semester's or quarter's work. Research in teaching is equally important with research in isotopes and human physiology, provided the person conducting the research is well trained in the fundamental sciences.

We have criticized the survey or generalized courses that cover more than one field of science, and I believe justly so. The state high school visitors office has said that the poorest planned and poorest taught courses in the curriculum of our high schools are the so-called general science and biology as they are most commonly planned and taught. It is worthy of note that the University of Chicago and the Ohio State University both found that their students (in general botany at Ohio State and in the first year of biological science at the University of Chicago) who did the best work did not have biology in high school, and those who had biology in high school did less well. My colleague and I

found that the students who had courses in botany and zoology in high school were most likely to do well in college botany and college zoology, and that many of those who had the high school biology were low in achievement.

Another "sliver" that needs to be examined on the Hopkins log is the time honored plan of college courses that have lectures given by one teacher, the laboratory conducted by other teachers or graduate students who are more interested in an advanced degree than anything else, and a so-called quiz section often conducted by a third person. Students have long criticised science courses conducted in this lecture-laboratory-quiz plan, but the staffs of our colleges have for an equally long time ignored these criticisms. This is one of the places where, I believe, the professors of education have been justified in criticising the beginning science courses. There is accumulating evidence that the laboratory-discussion method of teaching a science is superior to any method yet devised. A number of colleges and universities are now working with this plan of presenting a science with much success. The laboratory-discussion method of teaching science begins with the laboratory as the source of information for the student, and has some aspects of real research for these beginning students. The textbook becomes a reference book and not the source of information. One teacher conducts the class throughout the term so that the students feel that the work is organized and presented in a definite sequence that is conducive to learning. This is commonly lacking in the lecture-laboratory-quiz method if the statements of several generations of students are to be believed.

Another sliver that almost amounts to a plank on the Hopkins log is the teaching load and overload of the high school teachers who are sending their students to us in the colleges. A study made by E. F. Potthoff of the University of Illinois has shown that in this state "3,490 teachers were teaching a total of 716 different teaching combinations of subjects. The average number of teachers per combination therefore was slightly less than 5, . . . and 96 per cent were taught by not more than twenty teachers. . . . More than three-fourths of the total number of combinations consisted of three or more subjects. The general picture presented by these results is that conditions with respect to subject combinations are chaotic." This is not peculiar to Illinois.

This situation can be corrected, and the responsibility in Illinois rests with the Office of the State Superintendent of Public Instruction and the College of Education and the office of the High School Inspector of the University of Illinois. The State Teachers Colleges have to date been followers and not leaders in maintaining the accrediting standards for our high schools. The bulletin of the University of Illnois entitled "The Recognition and Accrediting of Illinois Secondary Schools" was compiled by the University and the Office of the State Superintendent of Public Instruction in 1940. This was a real improvement over the previous standards but it has not been rewritten since that time.

There are criteria given for the minimum, medium, and superior preparation of teachers in all subjects. The minimum preparation for teaching botany or zoology is 8 semester hours. But if biology is taught the teacher only needs 5 hours of botany and 5 hours of zoology and 6 semester hours in some other courses in the biological sciences. In other words the high

school teacher needs less preparation in subject matter to teach a course of study that includes all of the biological sciences than to teach any division of the sciences in that group.

The physical sciences are evidently more difficult than the biological sciences, for according to the 1940 bulletin to teach chemistry or physics the teacher must have 10 semester hours in each and should have a minor in mathematics. If astronomy is taught in the high school that is not so difficult for only 5 hours of college preparation is required if the teacher has 16 semester hours credit in the physical sciences.

General science is expected to include physics, chemistry, botany, zoology, physiology, physiography or geology and astronomy and lately meteorology but the teacher can teach general science if he has to his credit 6 to 10 semester hours in the biological sciences and 6 to 10 semester hours in the physical sciences. It apparently makes little difference as to what courses are included.

But to teach speech in Illinois high schools the teacher must have 16 hours of college credit in courses in speech, exclusive of the required courses in oral and written English that are a part of the first year's work in college.

Since our high schools have 716 different teaching combinations and since the minimum accrediting standards for science teacher preparation in this state are so low, is it any wonder that many of our college and university graduates try to qualify for certificates in as many teaching combinations as possible? As a result they are often well prepared in only one subject and sometimes not well prepared to do superior teaching in that subject.

One remedy for the poor teaching that exists in our public schools is to simplify teaching combinations, to increase accrediting standards for teacher preparation, and to give the teachers time for preparation of laboratory materials so necessary for good science teaching.

The Illinois State Academy of Science through the committee on the Teaching of the Sciences has recommended to the Office of the State Superintendent of Public Instruction and to the Office of the High School Visitor of the University of Illinois that the following criteria be made a part of the accrediting standards for the teachers in the schools of Illinois.

1. We have recommended that no teacher of any subject be permitted to teach without a minimum of 16 semester hours in that subject, and that if combination subjects be permitted the teacher must have 16 semester hours in each subject of the combination. For example if physical science is taught the teacher must have 16 semester hours work in chemistry and the same in physics; if biology is taught as a combination course the teacher must have 16 semester hours of botany and 16 semester hours of zoology. It is of course expected that the hours of credit must be in courses of study that can furnish the material for high school classes.

2. If general science continues to be permitted it is recommended that the teacher must have a year's work in at least three of the subjects included in general science as it is now taught and a minor (16 semester hours) in one of the three. Personally, I believe general science should be dropped from high school curricula.

It is obvious that the log of Mark Hopkins is no longer adequate for the equipment necessary for the work of either college or high school, at least in the sciences. The teacher and his preparation is of first im-

portance, the plan or method of teaching and the laboratory equipment are probably equally important if our students are to have a square deal.

If the colleges and universities can obtain objective evidence and use that as well as the best subjective evidence for the training of science teachers, the work in our high schools will improve and as a result we will have better trained students than we now have in our first year college classes. To arrive at this improvement we as college teachers must obtain satisfactory objective evidence that our college courses are well planned and well administered.

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PROGRAM FOR THE 41st ANNUAL MEETING
PAPERS PRESENTED

ARCHAEOLOGY AND ANTHROPOLOGY

IRVIN PEITHMAN, *Chairman*
Carbondale

1. Review of Archaeological Societies and Journals in the United States; C.C. BURFORD, Urbana.
2. Dust, Bones, and Rocks: C. JOE THOMAS, Cobden.
* 3. Steuben Village Site, A Hopewellian Village of Central Illinois; ETHEL SCHOENBECK, Peoria.
4. The Southern Death Cult in Illinois: BRUCE W. MERWIN, Southern Illinois University, Carbondale.
5. The Case of the Unknown Boy: J. C. MCGREGOR, Illinois State Museum, Springfield.
6. Northeastern Influences in Maple Mills Culture: DONALD WRAY, University of Illinois, Urbana.

BOTANY

B. W. WELCH, *Chairman*
Southern Illinois University, Carbondale

SECTION A

1. Prairie Flora in Kodachrome: THEODORE M. SPERRY, Kansas State Teachers College, Pittsburg, Kansas.
2. Study of the Deciduous Forest at Funk's Grove, Illinois: HOWARD R. CLARK, Lewistown.
* 3. Initial Report on the Vegetation of McDonough County: R. MAURICE MYERS, Macomb and PAUL G. WRIGHT, Carthage.
4. A Taxonomic Study of the Vascular Plants of Richland County, Illinois: VERA L. SCHERER, University of Illinois, Urbana.
5. The Genera of Clavarioid Fungi to be Expected in Illinois: MAXWELL S. DOTY, Northwestern University, Evanston.
6. University of Illinois Herbarium: EDNA L. MEADOWS, University of Illinois, Urbana.
* 7. Pioneers in Natural History and Biology in Southern Illinois: WM. M. BAILEY, Southern Illinois University, Carbondale.
* 8. The Monob'epharidaceae as Represented in Illinois: E. S. BENEKE, University of Illinois, Urbana.
9. Notes on Myxomycetes from Illinois: RICHARD K. BENJAMIN, University of Illinois, Urbana.
10. A New Aquatic Pythium: ADRIAN W. POITRAS, University of Illinois, Urbana.
11. A Check List of the Vascular Plants of Winnebago County: GEORGE D. FULLER, Illinois State Museum, Springfield, and University of Chicago. Read by title.
12. The Milk Weeds of Illinois: GRACE LOESCHER EYSTER, University of Illinois, Urbana. Read by title.

* Published in this volume.

SECTION B

1. Recurrent Ear-shoot Proliferation in *Zea mays*: O. J. EIGSTI, Northwestern University, Evanston.
2. Morphology of Winged Pollen Grains of Pennsylvanian Age: R. M. KOSANKE, State Geological Survey, Urbana.
3. A Study of the Anatomical Structures of the Stem of *Cunila origanoides* as it forms "Frost Flowers": AMY MAE JONES, Southern Illinois University, Carbondale.
4. Resting Root Primodia in Willows: MARGERY C. CARLSON, Northwestern University, Evanston.
5. Photosynthesis in Relation to Stomatal Frequency and Distribution: RALPH O. FREELAND, Northwestern University, Evanston.
* 6. Thinning Returns from an Eastern White Pine Plantation in Ogle County: RALPH W. LORENZ, University of Illinois, Urbana.
7. Preliminary Report on the Use of Brilliant Cresyl Blue as a Stain for Plant Chromosomes: WILSON N. STEWART, University of Illinois, Urbana.
* 8. The Genus Anemone in Illinois: JOHN W. HALL, University of Illinois, Urbana.
9. Secondary Succession in Relation to Depth of Burning in a Michigan Peat Bog: M. E. BRITTON and JANE W. ROLLER, Northwestern University, Evanston.
10. Seasonal Variations in Soil Temperature at Evanston, Illinois: M. E. BRITTON, Northwestern University, Evanston.

CHEMISTRY

SISTER MARY MARTINETTE, *Chairman*
Mundelein College, Chicago

1. X-rays in the Art Galleries: G. L. CLARK, University of Illinois, Urbana.
* 2. Quantized Qualitative Analysis: W. P. CORTELYOU, Roosevelt College, Chicago.
3. Chemistry for Home Economics Students: R. A. SCOTT, Southern Illinois University, Carbondale.
4. The Oxidation of Alpha Methyl Glucoside: MRS. ROSALIE LEUTGOEB, Mundelein College, Chicago.
5. Grignard Potentials: W. V. EVANS and F. CASSARETTO, Loyola University, Chicago.
6. New Frontiers of Fluorspar in the Chemical Industry: G. C. FINGER, Illinois State Geological Survey, Urbana.
7. Technical Editing as a Career for Bachelors of Science: MRS. ETHALINE CORTELYOU, Armor Research Foundation of Illinois Institute of Technology, Chicago.
* 8. The Dysonian System of Organic Notation: C. W. BENNETT, Western Illinois State Teachers College, Macomb.
9. Detection of DDT in Corn Residues: MRS. JOAN SANDBERG, University of Illinois, Urbana.
*10. A Method for Recalling the Configurations of the Aldohexoses: T. G. KLOSE, Loyola University, Chicago.
11. Proof of Structure in Organic Chemistry: J. V. KARABINOS, St. Procopius College, Lisle.
12. An Elementary Introduction to Analytical Chemistry: J. LESTER DALTON, University of Illinois, Galesburg Division.
13. Chemical Factors Influencing the Growth of Tubercle Bacilli; Development of Resistance to Sulfone Drugs and Antibiotics: BEN C. SHER, Municipal Tuberculosis Sanatarium, Chicago.
14. Industrial Electroplating: E. H. HADLEY, Southern Illinois University, Carbondale.
15. Modern Oil Refining: GUSTAV EGLOFF, Universal Oil Products Company, Chicago.

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GEOGRAPHY

JOHN L. PAGE, *Chairman*
University of Illinois, Urbana

1. Gainesville, Florida—Core of a Unique Geographic Region: J. EDWIN BECHT, University of Illinois, Urbana.
2. Some Geographical Aspects of the Electrical Revolution: W. O. BLANCHARD, University of Illinois, Urbana.
3. Mexico's Proposed T.V.A.: DOROTHA GARRISON, University of Illinois, Urbana.
4. A Square Mile of Normandy—Aerial Photographs for Regional Studies: ELTON M. SCOTT, Eastern Illinois State College, Charleston.
5. Agricultural Land Use in Iowa: HELEN L. SMITH, Wheaton College, Wheaton.
6. Illinois Railroad Geography: ALFRED W. BOOTH, University of Illinois, Urbana.
7. Cairo's Manufactural and Shipping Activities: J. HERBERT BURGY, Bradley University, Peoria.
* 8. Occupance of the Moraine Border of Northern Illinois: JOHN H. GARLAND, University of Illinois, Urbana.
9. An Undiscovered Playground of Illinois: Mary Grant, University of Illinois, Urbana.
10. The Pottery Industry of Greene County, Illinois: JOHN F. LOUNSBURY, University of Illinois, Urbana.
11. Geographic Limits of the Illinois Portion of the St. Louis Fluid Milk Region: ELIZABETH D. STRASSER, University of Illinois, Urbana.

GEOLOGY

LELAND HORBERG, *Chairman*
University of Chicago, Chicago

1. Study of the Structural Development of the Upper Horse Creek Area, Teton County, Wyoming: VIRGIL J. KENNEDY, B. WALDEN LYNCH, HOWARD L. PATTON, LINDELL H. VAN DYKE, University of Illinois, Urbana.
2. The Spheroidal Weathering Cycle and its Possible Use in Interpreting Events in a Granite Area in Iron County, Missouri: PERCIVAL ROBERTSON, The Principia College, Elsah.
3. Caliche in Southeastern New Mexico: LELAND HORBERG, University of Chicago, Chicago.
4. Geology and Limnology: JACK L. HOUGH, University of Illinois, Urbana.
5. Lineation of Stream Patterns in Illinois and its Interpretation: MAX C. FIREBAUGH, University of Illinois, Urbana.
6. Silurian Rocks in the Vicinity of Naperville, Illinois: C. L. BIEBER, DePauw University, Greencastle, Indiana.
7. Everything but the Contours: MARGARET A. PARKER, Illinois State Geological Survey, Urbana.
* 8. Oil Accumulation in the Cypress Sandstone in the Herald Pool, White County, Illinois: NANCY MCDURMITT, Illinois State Geological Survey, Urbana.
* 9. Coal Resources of Franklin County: GILBERT H. CADY, Illinois State Geological Survey, Urbana.
10. Coal Resources of White County: JOHN A. HARRISON, Illinois State Geological Survey, Urbana.

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PHYSICS

GLEN W. WARNER, *Chairman*
Wilson Junior College, Chicago

1. Electron Triplets: P. G. KRUGER and J. A. PHILLIPS, University of Illinois, Urbana.
2. The Physics Teacher and Wartime Training Methods: CHALMER N. PATTERSON, Bradley University, Peoria.
3. A Quantitative Experiment with a Gyroscope: PHILIP A. CONSTANTINIDES, Wilson Branch, Chicago City College, Chicago.
4. High Speed Automatic Computers: ARNOLD NORDSIECK, University of Illinois, Urbana.
5. The Proposed I.A.S. Sponsored Research Foundation: OTIS B. YOUNG, Southern Illinois University, Carbondale.
6. Rectifiers and Multipliers for Use in AC-DC Voltmeters: GLENN Q. LEFLER and ORA L. RAILSBACK, Eastern Illinois State College, Charleston.
7. Evidence about Neutrinos: C. W. SHERWIN, University of Illinois, Urbana.
8. Preliminary Survey of Water Currents in the Bosphorus: ROSCOE E. HARRIS, University of Illinois, Navy Pier, Chicago.
9. Research in the Teaching of Physics: H. CLYDE KRENERICK, Milwaukee, Wisconsin.

PSYCHOLOGY AND EDUCATION

D. M. HALL, *Chairman*
University of Illinois, Urbana

1. Conceptions of Democratic School Administration, 1920-1946: OGDEN H. GLASOW, Western Illinois State College, Macomb. Read by title.
*2. Education Plans of High School Students in Relation to Financial Situation and Academic Aptitude: DON THOMANN, High School Testing Bureau, University of Illinois, Urbana.
3. Job Satisfaction in Chicago: WILLARD A. KERR, Illinois Institute of Technology, Chicago. Read by title.
4. Speech-Thought Relationship: RICHARD G. SONGER, James Millikin University, Decatur.
5. Behavior and the Formative Mode: GERTRUDE HENDRIX, Eastern Illinois State College, Charleston.
6. Measures of Visual Ability as Related to Believed Acuity: GEORGE L. KNEDLIK, Illinois Institute of Technology, Chicago. Read by title.
7. An Empirical Study of the Validity of Non-Assumption Statistics in Skewed Psychological Data with Evaluation of a New Measure of Variability, the Tripartile Deviation: WILLARD A. KERR and MELVIN RUDOLPH, Illinois Institute of Technology, Chicago.
8. A Program for Science Teacher Training: ARNOLD J. HOFFMAN, Eastern Illinois State College, Charleston.

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SOCIAL SCIENCE

LYNFORD A. LARDNER, *Chairman*
Northwestern University, Evanston

1. Physiocratic Doctrine in Ancient China: LEWIS A. MAVERICK, Southern Illinois University, Carbondale.
2. A New Orientation in the Social Sciences: S. R. KAMM, Wheaton College, Wheaton.
3. Heart Disease—Its Impact on our National Life: C. C. BURFORD, Urbana.
* 4. Administrative Problems of Township Government in DuPage County: HAROLD GORDON, Wheaton College, Wheaton.
5. Historical Rhythm in American Foreign Policy: FRANK L. KLINGBERG, Southern Illinois University, Carbondale.
6. Patterns of Rural-Urban Voting in Illinois: R. G. BROWNE, Illinois State Normal, Normal.

ZOOLOGY

WALTER M. SCRUGGS, *Chairman*
Eastern Illinois State College, Charleston

1. A Summary of Bionomic Studies on the Ambush Bug: WALTER V. BALDUF, University of Illinois, Urbana.
2. Changing Fish Populations as an Index to Pollution and Soil Erosion: JOHN D. BLACK, Eastern Illinois State College, Charleston.
3. Oviposition and Egg Hatching in a Delpliacid, *Megamelus davisi*: C. S. SPOONER, Eastern Illinois State College, Charleston.
4. Parasites of the Ranidae (Amphibia) VII: A. C. WALTON, Knox College, Galesburg.
5. Distribution of Fishes in the Middle Fork River: ARTHUR O. FLESHSIG, University of Illinois, Urbana.
6. Geographic Variation in the Penetrance and Expressivity of the Mutation "Notched" in *Drosophila macrospina*: SIDNEY MITTLER, Illinois Institute of Technology.
* 7. Zooplankton of Craborchard Lake during the First Year, 1941-1942: TROY C. DORRIS, Quincy College, Quincy.
8. Color Reactions with Malignant Tumors: EMIL WEISS, Peoples Hospital Chicago.
9. Situs Inversus Viscerum in Cat and Man: JAMES M. SANDERS, University of Missouri, and MURIEL BEUSCHLEIN, Chicago Teachers College, Chicago.
10. Effect of d-Amphetamine on Gastric Hunger Contractions and Food Intake in the Dog: WILLIAM SANGSTER, M. I. GROSSMAN, and A. C. IVY, Loyola University and University of Illinois College of Medicine, Chicago.
*11. Sex and the Altitude of Flight in *Cyclocephala* (Coleoptera: Scarabaeidae): GARLAND T. RIEGEL, University of Illinois, Urbana.
12. An Anomalous Gall Bladder of the Domestic Cat: ALBERT G. SMITH and WILLIAM SANGSTER, Loyola University, Chicago.
*13. A Mosquito Survey of Lake Bloomington, McLean County, Illinois: HAROLD L. MANUEL, Illinois State Normal University, Normal.
14. Comparative Weights of Normal and Hypophysectomized Chick Embryos with Reciprocal Grafts of Thyroid Glands: FLORENCE M. FOOTE and CHARLES L. FOOTE, Southern Illinois University, Carbondale.
15. Some Unknowns in Wildlife Management and Research: WILLET N. WANDELL and HARLOW B. MILLS, State Natural History Survey, Urbana.

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ARCHAEOLOGY AND ANTHROPOLOGY

STEUBEN VILLAGE SITE, A HOPEWELLIAN VILLAGE OF CENTRAL ILLINOIS

E. SCHOENBECK
Peoria Academy of Science, Peoria

The Steuben Village site is reported here as known from explorations and collections made by the George Schoenbecks, members of the Peoria Academy of Science, since 1939 during which time about fifty collecting trips were recorded.

The site, listed as site 22 of the Peoria Academy of Science Survey and recorded also among the sites of the state in the Illinois State Museum Survey, is located on the west bank of the Illinois River about three miles north of Chillicothe, in Marshall County, Steuben township, section 34, T. 12 N, R. 9 E. It is a flat gravelly area of about five acres, lying between the river and the bluff. The C. R. I. & P. railroad and route 29 cut through its west side and a small creek runs through the south end.

There are eight mounds on the bluff, one of them about 114 feet long, but it is not known whether or not these belong to the village.

Material is known from the plowed surfaces of several slight ridges, from post-holes and shallow excavations, and from a lower level exposed in the bed and banks of the creek. The buried occupation level lay immediately under a layer of gravel several inches thick, and at one place was 7 feet below the present surface.

Photograph by E. Schoenbeck.

FIG. 1.—The largest of the eight mounds on the bluff above Steuben village site measures about 84 by 114 feet. It has not yet been determined whether or not these mounds belong to the village.

Much excellent material is said to have been obtained by earlier collectors.

Material collected is Hopewellian, with the exception of a small amount of cord-decorated pottery, and includes chert items, bone refuse and bone tools, stone items, mica, red ochre, shell articles and refuse, and pottery.

Items of particular interest are the stone human head effigy[1] and a pink chert bird effigy. Another bird effigy is in the Leroy P. Elliott collection. Conspicuous in the chert artifacts are the large number of medium-sized notched points and narrow flake knives. Of interest in the pottery is the 3 to 1 proportion of punctate to dentate stamp, with both decorations of the simplest types, and some red-painted and thickened-rim ware.

About 950 rims and some thousands of body sherds are in the pottery collections. Types included are Woodland plain (or smoothed); Woodland cord-roughened; Sister Creeks punctated; Naples dentate stamped; fine limestone-tempered Hopewell with cross-hatched incised and rocker-stamped rims; red-painted thickened-rim ware from the lower Mississippi Valley; incised; brushed; bar-stamped; Clear Lake cord-wrapped-paddle-edge stamped; and Maple Mills or Gooden cord-decorated.

A light colored wash shows on some of the sherds and there are two examples of the bored hole in the vessel wall.

The punctated sherds include 525 rims and 66 lower rims; 73 are punctated on the lip; 8 bear disk or circle punctates. All others are simple two to three punctates in arrangements on the rim.

The dentate-stamped sherds include 157 rims and 83 lower rims. Only 8 have any but the simplest stamp, placed vertically and singly without elaboration.

There are 103 Woodland cord-roughened and 68 Woodland plain; 13 others are bossed. The cord-wrapped-paddle-edge stamped include 10 rims, some thin, others heavier. The cord-decorated includes one lower rim of the usual decoration and 17 body sherds; there is also a rim showing cord punctates on a plain surface. A collared rim may or may not be of this type.

The finer Hopewell and imitations have 31 cross-hatched incised rims, rocker stamp, etc. There are three red-painted and three of the thickened rim, one of which is red filmed and one of which bears incised designs on the wide rim. There are 50 rocked or zoned, limestone-tempered or leached body sherds and one portion of lobed body.

A part of the "brushed" ware is limestone tempered.

Chert items number in the hundreds, and considering the other known and reported collectors, must have been very abundant. Points, knives, scrapers and spuds are the principal items. Points, many of them crude, are mostly notched, some are stemmed and some are lanceolate, and they total about 500. Flake knives are plentiful. Scrapers are of several types. The bird effigy is two inches long.

Collections made in earlier years must have contained many fine pieces because the casual collector generally picks up only perfect items and chert was so plentiful on the site. Large specimens of the fine Hopewellian blades are among items reported.

Bone tools comprise only four awls and one cut antler, but refuse animal bones and teeth are present

[1] Described in 1947 Transactions, Illinois State Academy of Science under title, "A Seven-pound Copper Axe Among 1946 Hopewell Discoveries."

in some quantity. Many are rotten and deteriorate quickly. Fish otoliths are numerous.

Two shell hoes are among the shell remains; each shows the round hole in the center.

The stone material includes portions of 15 pendants; all seem to be oblong, none are reel-shaped. Other items are many pitted hammer stones; a few celts and axe portions; ball-shaped chert pecking stones; a few shaped disks and several grooved mauls.

The finely executed sandstone human head effigy, reported in 1947 *Transactions*, has since been compared closely with one found at the Twenhafel site in Jackson County of southern Illinois and it was the unanimous opinion of Thorne Deuel, Director of the Illinois State Museum, George K. Neumann of Indiana University, and Mr. and Mrs. George Schoenbeck, that the two heads might have been made by the same hand. The Twenhafel head differs by having a headdress, but both have the same highly stylized ear and show similar workmanship. James B. Griffin, Curator of the Ceramic Repository, University of Michigan, states that a similar one has been found in Oklahoma.

A brief comparison of the Steuben material with that from the Hopewellian Clear Lake village might be of interest here. The Steuben site has much more chert and more pendants. Few bone tools have been found at Steuben, but collecting mostly from the surface rather than from excavations must be taken into consideration.

A comparison of pottery brings out the predominance of punctate over dentate stamped at Steuben and the reverse at Clear Lake; a scarcity of cord-wrapped-paddle-edge at Steuben and an abundance at Clear Lake; a complete lack of the black sands incised ware and a mere representation of the cord-decorated at Steuben, while Clear Lake has a good showing of the first and the largest amount of cord - decorated ware known from any Illinois site. Steuben dentate-stamp lacks the elaborated arrangements and variations and shows no bossing, whereas Clear Lake has an abundance of such. The heavy crushed rock or Fayette thick ware is lacking at Steuben but is also rare at Clear Lake.

Neither site had a Mississippian occupation; Clear Lake had but a few sherds of Mississippian pottery and Steuben had none.

BOTANY

SOME PIONEERS IN NATURAL HISTORY AND BIOLOGY IN SOUTHERN ILLINOIS

WILLIAM M. BAILEY
Southern Illinois University, Carbondale

Cyrus Thomas

When the Southern Illinois Normal University opened its doors to students in 1874, there was on the faculty a biologist and naturalist of national reputation, Cyrus Thomas, who became one of the foremost early systematic and economic entomologists.

Cyrus Thomas was born July 27, 1825, at Kingsport, Tennessee. He attended the schools of his native state. As a young man he began the study of law. He moved to Illinois in 1849. For a short time after coming to Illinois he was engaged in teaching school. Later he was appointed deputy county clerk in the office of John A. Logan, who was county clerk of Jackson County.

In 1851 Thomas was elected county clerk of Jackson County. About this time he was admitted to the bar. He held the office of county clerk for one term, and at the expiration of his term of office he began the practice of law at Murphysboro. While engaged in the practice of law he also applied himself to the study of natural history.

In 1864, upon the death of his wife, who was a sister of John A. Logan, he abandoned law, and entered the ministry of the Lutheran Church, a profession for which he had been quietly making preparation.

During the period from 1869 to 1873 Thomas served as entomologist and botanist on the United States Geological and Geographical Survey of the Territories, under Ferdinand V. Hayden. Thomas's reports, published with the reports of the expedition, constituted an important feature of these publications.

In 1874 Cyrus Thomas was appointed a member of the faculty of the Southern Illinois Normal University, beginning his work in this institution at the opening of the fall term that year. His salary, $1800 per year, was the highest paid to any member of the faculty except the president, then called the principal. He was listed as teacher of natural history and physiology, and later as also curator of the museum.

In 1875 Thomas was appointed State Entomologist of Illinois. He was then able to devote only a part of his time to the work in the Southern Illinois State Normal University.

During the period from 1874 to 1876 vast areas of the plain west of the Mississippi River were devastated by the Rocky Mountain locust, or grasshopper. In order to meet this problem, Congress provided for the appointment of the United States Entomological Commission, of which Charles V. Riley was made Chairman, and Cyrus Thomas and A. S. Packard, Jr. were appointed the other members. Thomas was made treasurer of the commission. He had made a special study of the Acrididae (true locusts, or grasshoppers), had been connected with the United States Geological Survey as an en-

tomologist from 1869 to 1873, and was State Entomologist of Illinois. His work on the Commission necessitated the severance of his connection with the Southern Illinois Normal University. The work of the Commission was begun in 1877 and completed in 1882. It constituted an important step in the development of economic entomology in the United States.

After the completion of the work of the United States Entomological Commission, Cyrus Thomas devoted the remaining twenty five years of his life to work in archaeology and ethnology with the Bureau of American Ethnology, under the Smithsonian Institute. He became a recognized authority on the Cherokee and Shawnee Indians, and the Maya inscriptions and codices. He remained active in the later years of his life. When he was eighty-four years of age, it was said that he was mentally as active as ever. He died June 27, 1910, at the age of eighty-four years and eleven months.

Thomas published his first paper in 1859, in the *Prairie Farmer*, on the chinch bug. He continued to publish articles on entomological subjects in the *Prairie Farmer* and the *Illinois Farmer* for a number of years. In the *Transactions of the Illinois Horticultural Society* for 1877-78 he publjshed a rather long article covering a number of injurious insects. His third report as State Entomologist, published in 1879, contained the first comprehensive taxonomic study of the homopterous family Aphididae (Aphids) published in America. His most important paper was the synopsis of the Acrididae (true locusts, or grasshoppers) of North America, published in 1873. He named many new species in the Acrididae and the Aphididae.

George Hazen French

George Hazen French was born in central New York March 19, 1841. He attended the rural schools of his native region. In the fall of 1859 or 1860 he entered Cortland Academy as a student. He attended this academy two terms. This was the only schooling he had above the common rural schools of that time. In the botany class in the academy he did his first work in the identification of plants. He evidently showed unusual interest and ability in this work, as he received from Professor Woods, author of the textbook used, an invitation to go with him on a collecting trip in the west.

French began teaching in the rural schools of central New York, in the fall of 1861. His salary was $1.75 per week or $7.00 per month and board. He got the board by "boarding around" among the patrons of the school. This was the custom in the district schools at that time. French wrote in the notes on his life experiences that the salary was not exceptionally low. He continued to teach in the rural schools of central New York for several years.

He then came west to Illinois and taught in the schools of this state. In 1868 he passed the state examination given by Newton Bateman, State Superintendent of Illinois, and received a state certificate.

In the fall of 1868 French accepted a position as science teacher in the Illinois Agricultural College, Irvington. He stated in his notes that he "had never seen the inside of a college." He had studied chemistry and other sciences while teaching. He continued to teach sciences in the college at Irvington for nine years.

One of the things that had an important influence on the later work

of French was his meeting with George W. Vasey, a botanist, who had made a collecting trip in the west under government patronage. He taught French how to mount plants in the proper way. The latter began vigorously to carry on the work of collecting plants and making exchanges with other botanists. He discovered a new species of shooting star (Dodecatheon) in this region, which Vasey named in his honor *Dodecatheon Frenchii.*

French studied Greek with the daughter of the president of the college at Irvington. He had also learned some French. The college began publishing B. Sc. after his name, and at the commencement in 1874 conferred the A.M. degree upon him.

When in 1877 Cyrus Thomas was appointed a member of the United States Entomological Commission, French became his assistant. In August of 1877 French moved to Carbondale where he served as Assistant State Entomologist, working in the museum of the Southern Illinois Normal University. On July 1, 1878 he became a member of the faculty of this institution, as instructor in natural sciences, and curator of the museum. His subjects were zoology, botany, and physiology. He held this position for thirty-six years. He continued his work as Assistant State Entomologist for about two years after coming to Carbondale.

Soon after moving to Carbondale, French began writing for the scientific press. He wrote and published a manual on the butterflies of this region which passed through three editions. He also wrote a manual on the mushrooms of the region.

On the afternoon of November 23, 1883, the building of Southern Illinois Normal University was destroyed by fire and the museum was destroyed with it. Only the herbarium and a few cases of insects were saved. In the years that followed, French built up another museum, better than the one that had been destroyed. Most of the specimens and collections were the results of his own work.

French became widely known for his entomological work. He was a member of the A.A.A.S., the Illinois State Academy of Science, the Entomological Society of France, the Entomological Society of Belgium, and other scientific organizations. His life came to a close January 2, 1935, when he was ninety-three years old.

John P. Gilbert

Professor John P. Gilbert was the first biologist on the faculty of the Southern Illinois Normal University with university training.

John Philo Gilbert was a native son of Southern Illinois. He was born on a farm in Jefferson County July 27, 1872. His early education was secured in the country schools. He was bereft of the care and help of his parents early in life, as the death of his mother occurred when he was seven years of age and that of his father when he was sixteen. Thus he was left to plan his own career with the assistance of the older children of the family.

He began his educational career as a country school teacher. He entered the Southern Illinois Normal University as a student in 1892. After four years of active school life in this institution, during which he became prominent in debate and oratory, he graduated in 1896. After his graduation he advanced rapidly in the teaching profession, holding such responsible positions as the principalship of the high schools of Olney and Mattoon, and the superintendency of the schools of Tuscola.

In 1903 Mr. Gilbert entered the University of Illinois. Here he pursued his biological studies and also taught biology in the academy of the University. At the University he received the bachelor's degree in 1905 and the master's degree in 1906. He won high honors as a member of a debating team that won an intercollegiate debate between the University of Illinois and the University of Indiana. In the University of Illinois he was elected to the honorary scientific fraternity Sigma Xi.

In 1911 Gilbert became head of the Department of Biology of the Southern Illinois Normal University. This position he filled with conspicuous success. In 1920 he was given a leave of absence beginning September 1, in order that he might serve as secretary of the Southern Illinois Development Association. Within a year his health, which was already impaired, failed completely, and on April 10, 1921, the hand of death cut short his useful life in the 49th year of his age.

For some time Gilbert was active in chautauqua work, carrying the messages of nature study to children and adults. Upon the decline in the work in the chautauquas, he participated actively in the work of the State Farmers' Institute of Illinois. He was a man of wide and varied interests. The State Dairy Association, State Poultry Association, and the horticultural interests of Southern Illinois received his active support. He was active in church, lodge, and other worthy community enterprises. Gilbert's energy and ambition, his intellectual ability, his abounding optimism and his ability as a public speaker made him a strong factor in the advancement of Southern Illinois.

In this paper we have considered the work of a very few among many pioneers. May we remember with appreciation the work that the pioneers did, often under great handicaps, and the foundations that they laid.

THE MONOBLEPHARIDACEAE AS REPRESENTED IN ILLINOIS*

E. S. BENEKE
University of Illinois, Urbana

The Monoblepharidaceae form a small family of aquatic fungi containing three genera, *Monoblepharis*, *Monoblepharella*, and *Gonapodya*, with a total of about 13 species. Interest in this family developed when Cornu published his description of *Monoblepharis* in 1871. Thaxter (1895) was the second person to find these organisms, reporting species from the United States in 1895. The genus *Gonapodya* was described by Fischer (1892), and recently the genus *Monoblepharella* was established by Sparrow (1940). Four of the thirteen species are known to occur only in tropical or subtropical regions, while the others have been found in the temperate climates. This family is of special interest to students of mycology in that it is the only group of filamentous fungi possessing a large nonmotile egg fertilized by a small uniflagellate sperm. This has led to considerable study and speculation on the origin and relations of this group to other fungi and to certain of the algae. Further details of this family may be found in the most recent monograph of the group by Sparrow (1933), and in the comprehensive publication on aquatic Phycomycetes by Sparrow (1943).

Species of *Monoblepharis* are found primarily in permanent fresh water habitats on dead submerged twigs. These are found most frequently in cool waters early in the spring. Certain twigs, especially those of ash and birch, are more suitable for the requirements of the fungus. Species in the genus *Monoblepharella* have been isolated from wet soils in the sub-tropics or tropics. The habitat of *Gonapodya* is usually on twigs or submerged apple and rosaceous fruits.

Representatives of two of the three genera, and possibly of the third also, have been isolated from numerous collections of water and soil samples taken throughout the state of Illinois. Species in this family are rarely observed immediately after the twigs are brought in from the field and examined. However, when such twigs are put in charcoal treated filtered sterile distilled water at 8°C. to room temperature, tufts or pustules of delicate, pale-gray hyphae may appear over the twigs or only in openings of the lenticels. A temperature ranging from 8-11°C. is more favorable for the development of sporangia, while sexual reproductive structures develop more readily at room temperature. Some of the isolates remained sterile in spite of repeated attempts to induce sexual reproduction.

Species of the Monoblepharidaceae have certain well-defined characteristics that readily distinguish them from other groups in the Phycomycetes. The tufts of delicate hyphae extending from the lenticels of a twig consist of a rhizoidal system for

* The writer wishes to express his sincere appreciation to Dr. Leland Shanor for his helpful suggestions and advice in the preparation of this paper.

anchorage and absorption of foods, and slender straight branches. The well-developed filamentous mycelium contains protoplasm with regularly arranged vacuoles and oil globules, giving a foamy appearance. The hyphae may be terminated by sporangia which liberate posteriorly uniflagellate zoospores. These zoospores usually have an anterior group of refractive globules. After the zoospores leave the pore of the sporangium, they swim around for a time before settling on some suitable substratum, encysting, and germinating. In sexual reproduction, when known, the large, nonmotile egg, usually borne singly in each oogonium, is fertilized by a small posteriorly uniflagellate antherozoid. These are usually formed in an antheridium nearby on the same hypha. The fertilized egg becomes a thick-walled oospore that develops hyphae upon germination.

Out of a total of seven species of *Monoblepharis* that have been found in the temperate regions, the following species and one variety of the genus *Monoblepharis* have been collected in the state of Illinois. *Monoblepharis sphaerica* Cornu and *Monoblepharis polymorpha* Cornu have been encountered frequently, but *Monoblepharis macrandra* (Lagerheim) Woronin appears to be less common. *Monoblepharis macrandra* var. *laevis* Sparrow has been obtained only twice from these collections in Illinois. Sterile forms resembling *Monoblepharis regignens* Lagerheim and *Monoblepharis ovigera* Lagerheim have also been isolated. Some students of *Monoblepharis* and related genera have indicated that what we now know as *M. regignens* and *M. ovigera* might represent species of *Monoblepharella* if their method of sexual reproduction were known. Laibach (1927) has placed both of these in a separate genus, *Monoblepharіopsis*.

In the genus *Monoblepharis* the oospores are formed outside at the orifice of the oogonium or within the oogonium when sexual reproduction is known. The zygote is not flagellate. These two characteristics readily distinguish this genus from the genus *Monoblepharella*. The oospores in the genus *Monoblepharella* are formed outside of the oogonium and usually remote from it, while the zygote is flagellate and free-swimming. The hyphae in some species of *Monoblepharella* may develop swellings, a condition not observed in *Monoblepharis*. The sporangia are also comparatively wider and the zoospores are frequently produced in more than one row in *Monoblepharella*.

The genus *Gonapodya* is readily distinguished by its characteristic hyphae which have pseudosepta and which are usually constricted. Sexual reproduction is unknown in the genus. The hyphae are more irregular and frequently dichotomously branched, and the sporangia proliferate one to many times.

The characteristics and distribution of species found in Illinois follow:

Monoblepharis macrandra has antheridia that are usually conspicuously exserted as shown in figues 1, 2, and 3. The antheridia occur in younger plants on separate branches from the oogonia and in older ones they are hypogynous to the oogonia, the antheridia being strongly exserted. In this species the oospores normally have a thick brown wall covered by lighter colored bullations. This species was collected on ash twigs in a pond near the Kaskaskia River, Vandalia, Ill., April 22, 1947; on ash twigs in a pond near the little Wabash River, 4 miles east of Mason, Ill., April 22, 1947; and on poplar twigs in a pond near the Sangamon River, Riverton, Ill., May 11, 1947.

Monoblepharis macrandra var. *laevis* is similar to *M. macrandra* in the structure of the hyphae and the reproductive organs. A distinguishing difference as illustrated by figures 4 and 5, is the lack of any bullations on the oospore, making the thick dark brown wall smooth. Isolates of this species were found several times on elm twigs, in a pond, south of Yorkville, Ill., May 26, 1947.

Monoblepharis polymorpha is distinguished by the development of antheridia that are epigynous or appear to be inserted on the oogonia as illustrated in figures 6, 7, and 8. Isolates of this species have been found on hickory twigs in the Rocky Run, 7 miles south of Warsaw, Ill., May 20, 1947; on elm twigs in a pond south of Yorkville, Ill., May 26, 1947; and on ash twigs in a pond in Evansville, Ill., June 2, 1947.

The most commonly isolated species, *Monoblepharis sphaerica* is separated from other species which produce sexual reproductive structures by the formation of antheridia that are hypogynous, or immediately below the oogonia, and an antheridial tube which is scarcely exserted beyond the wall of the antheridium. These characteristics and the sporangia are illustrated in figures 9, 10, 11, 12, 13, and 14. This species has been collected on willow twigs in the Kaskaskia River, Shelbyville, Ill., April 22, 1947; on ash twigs in a pond, East Peoria, Ill., May 4, 1947; on oak twigs in the Illinois River, 10 miles northwest of Grafton, Ill., May 10, 1947; on elm twigs in a pond south of Yorkville, Ill., May 26, 1947; and on birch twigs in a branch of the Rayse Creek, 5 miles west of Mt. Vernon, Ill., June 3, 1947.

Both of the two recognized species of *Gonapodya* have been collected in Illinois. *Gonapodya prolifera* (Cornu) Fischer has long pod-shaped or siliquiform sporangia in contrast to the long oval sporangia of *Gonapodya polymorpha* Thaxter as illustrated in figures 15 and 16. The later species is more open and ramose than *G. prolifera*, and it is also usually found under less foul environmental conditions. *Gonapodya prolifera* was collected on *Crataegus* fruits taken from Six Mile Creek, 5 miles south of Bloomington, Ill., Oct. 20, 1947, and *G. polymorpha* was found on elm twigs removed from Middle Fork, near Benton, Ill., June 3, 1947.

Isolates of a very delicate fungus resembling the asexual aspects of *Monoblepharella* or the incompletely known species, *Monoblepharis regignens* Lagerheim and *Monoblepharis ovigera* have been recovered more frequently in this area than species with sexual reproductive structures present. Figure 17 shows a portion of a hypha of an isolate lacking sexual reproduction, showing a typical sporangium. These may extend up to 85 microns in length, a size more characteristic of the sporangia of the tropical species, *Monoblepharella elongata* Springer. The group of sporangia illustrated in figure 18 is characteristic of *Monoblepharis ovigera*. The swellings on some of the hyphae of one of the isolates, as shown in figure 19, are more characteristic of species of *Monoblepharella*, although it has failed to reproduce sexually. Attempts to induce sexual reproduction in these isolates by subjecting them to temperatures above those normally prevailing, a method used successfully by other investigators studying tropical and sub-tropical species, have not been productive when employed with these isolates obtained in Illinois.

Summary

The occurence of a large number of species in the small family Monoblepharidaceae is reported for Illinois. Out of a total of about 9 species reported for temperate climates, the following species have been isolated from the numerous collections of water and soil samples taken throughout the state. *Monoblepharis sphaerica* Cornu and *Monoblepharis polymorpha* Cornu have been encountered frequently, but *Monoblepharis macrandra* (Lagerheim) Woronin appears to be less common. *Monoblepharis macrandra* var. *laevis* Sparrow has been isolated twice from these collections. Both *Gonapodya prolifera* (Cornu) Fischer and *Gonapodya polymorpha* Thaxter have been found in this area. Isolates that failed to reproduce sexually and resemble the asexual aspects of species of *Monoblepharella* or the incompletely known species, *Monoblepharis regignens* Lagerheim and *Monoblepharis ovigera* Lagerheim, have been recovered frequently.

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Plate I

Explanation of Figures

Figs. 1-3. *Monoblepharis macrandra.* Figure 1 contains a young oogonium. Figure 2 shows the antheridium and oogonium separate, a condition occurring in young plants. In figure 3, a portion of the hypha showing sex organs with the antheridium hypogynous and strongly exserted.

Figs. 4-5. *M. macrandra* var. *laevis.* Both figures show portions of plants with antheridia and oogonia which have smooth-walled, exogenous oospores.

Figs. 6-8. *M. polymorpha.* These figures show portions of hyphae with sex organs that have antheridia appearing to be epigynous or inserted on the oogonia.

Figs. 9-14. *M. sphaerica.* Figures 9, 10, and 11 show portions of hyphae with oogonia, exogenous oospores and antheridia with slightly exserted antheridial tubes. Figure 10 also shows an empty sporangium. Figure 12 shows a hyphal tip with a young oogonium developing. Figure 13 illustrates another hypha terminated with sex organs. Figure 14 represents a portion of the plant with several sporangia.

Fig 15. *Gonapodya prolifera,* a small part of the plant showing hyphal segments and proliferated sporangia.

Fig. 16. *G. polymorpha,* a portion of the plant illustrating the ramose habit and some sporangia still proliferating.

Fig. 17. A portion of an isolate apparently lacking sexual reproduction, but producing long sporangia similar to *Monoblepharella elongata.*

Fig. 18. A portion of a plant which has not produced sex organs, showing a group of sporangia characteristic of *M. ovigera.*

Fig. 19. Sporangium on an apparently sterile hypha with swellings characteristic of some species of *Monoblepharella.*

All figures were made with the aid of a Spencer camera lucida. The magnifications of all the figures are approximately X258.

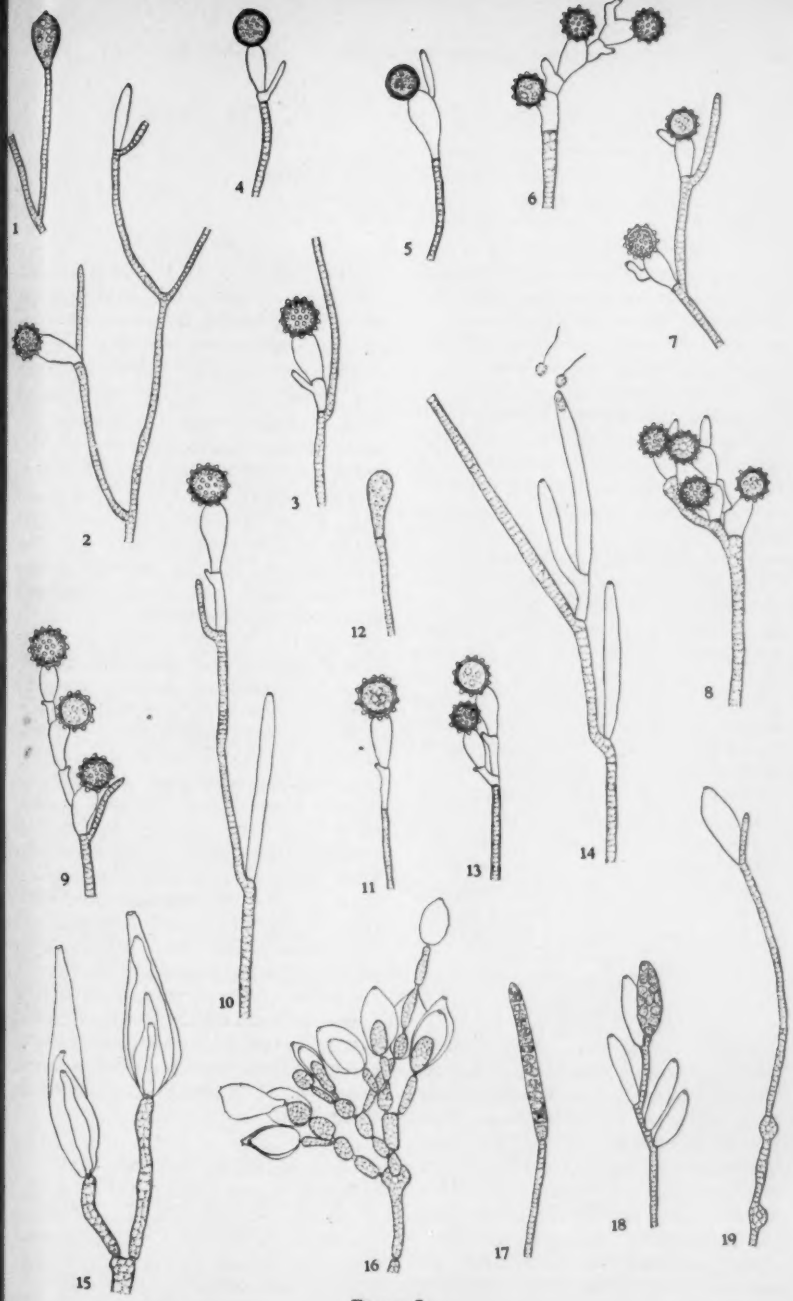

PLATE I

THE GENUS *ANEMONE* IN ILLINOIS

JOHN W. HALL
University of Illinois, Urbana

The genus *Anemone* is represented in Illinois by six known species. This taxonomic study is an attempt to evaluate the genus in Illinois from a study of herbarium specimens in the University of Illinois herbarium and the herbarium of the Illinois State Natural History Survey. Descriptions have been made of the salient features of the species; an artificial key is provided for their identification.

Type localities of the species are from their original descriptions; the distribution in North America has been adapted from Rydberg's *Flora of the Prairies and Plains*. Habitats have been recorded from information on herbarium labels. Common names are those given in *Standardized Plant Names*. The synonymy of each species is not intended to be exhaustive; only those synonyms are listed to which reference as to their occurrence in Illinois is recorded. Cited specimens are from the herbaria of the University of Illinois and from the Illinois State Natural History Survey (NHS).

Anemone L.
(*Pulsatilla* Adans.)

Erect, perennial herbs usually with horizontal rhizomes and basal leaves. Basal leaves petioled, palmately divided or dissected. Stem leaves whorled, forming an involucre remote from the flower. Flowers terminal, solitary or umbellate. Sepals 4-20, usually 5, petals lacking. Stamens numerous. Pistils usually numerous, maturing into achenes. Style persistent, short, or developing a long and plumose tail.

Opinions vary as to the limits of the genus *Anemone*, it having been variously divided by some authors into several genera, or these several genera combined by others into the one genus. Tournefort recognized both *Anemone* and the closely related *Pulsatilla*. Linnaeus, in the early editions of the *Genera Plantarum*, listed *Hepatica*, *Anemone* and *Pulsatilla*, but combined all three of these as *Anemone* in the first edition of the *Species Plantarum*. Later, Adanson recognized *Anemone* and *Pulsatilla*. In Gray's Manual the first four editions maintain *Pulsatilla* and *Anemone* as distinct from each other, but later editions include both under *Anemone*.

Hepatica, in which the involucre is close to the flower and is sepal-like, is a natural genus readily separated from *Anemone* and *Pulsatilla*. The latter groups are not as easily distinguished. The long plumose style and the occasional presence of abortive stamens of *Pulsatilla* are the only obvious characters which separate it from *Anemone*. In other respects, especially in the remoteness of the involucre from the flower and the similarity of perianth parts in both, the two are closely enough allied to include them in one genus, as they are so considered in this report.

Key to Species

1. Styles elongate, plumose; plants villous; leaf segments linear; sepals bluish-purple. *A. ludoviciana*
1. Styles shorter, glabrous or pubescent, not plumose.
   2. Stem leaves sessile.

3. Stem 2-6 dm. tall, arising from a rhizome; sepals 4-6, obovate, white. *A. canadensis*
3. Stem 8-20 cm. tall, arising from a small tubercle; sepals 6-20, linear, white or purplish. *A. caroliniana*

2. Stem leaves stalked.
4. Basal leaves numerous, simple, divided; flowers 1-several; achenes villous.
5. Leaf segments toothed above the middle, cuneate; styles 1 mm. long. *A. cylindrica*
5. Leaf segments toothed to below the middle, ovate to ovate-lanceolate; styles 1.5-2 mm. long.
4. Basal leaf solitary, compound, appearing after the flower; flower solitary; achenes glabrous or pubescent. *A. quinquefolia*

Anemone ludoviciana Nutt. Gen. Am. Pl. II: 20, 1818; Jones (1945) 131; Fuller (1946) 56.

Clematis hirsutissima Pursh, Fl. Am. Sept. 385, 1814.

Pulsatilla nuttalliana Spreng. Syst. II: 663, 1825; Bebb (1860) 183.

A. patens var. nuttalliana A. Gray, Man. Ed. 5: 36, 1867; Vasey (1870) 217; Patterson (1876) 1; Brendel (1887) 83; Higley & Raddin (1891) 1; Huett (1897) 2:163.

A. patens var. Wolfgangiana sensu McDonald (1890) 103; Robinson and Fernald (1908) 401; Gleason (1910) 155; Pepoon (1927) 208; not Koch.

P. hirsutissima (Pursh) Britt., in Ann. N. Y. Acad. Sci. 6: 217, 1892; Britton (1892) 217.

P. ludoviciana (Nutt.) Heller, Cat. N.A. Pl., Ed. 2:4, 1900; Rydberg (1932) 333.

P. patens sensu Britton and Brown (1913) 2: 102. Not (L.) Mill., Mill. Gard. Dict., Ed. 8, No. 4, 1768.

Type locality: "Commencing near the confluence of the river Platte and Missouri; on gravelly hills."

Range: Ill.—Tex.—Utah—Wash. —Alaska.

Perennial from a thick rhizome. Stem villous, 15-35 cm. tall. Leaves dissected into numerous divisions; basal leaves petioled, involucral leaves sessile. Peduncle bearing a solitary large purple or white flower. Sepals 5-7, ovate. Stamens numerous, the outer often sterile. Achenes in a globose head, with long plumose persistent styles. Amercian Pasque Flower.

In prairies, northern Illinois. Rare.

The earliest flowering and rarest species in Illinois, occurring only in the northernmost counties.

Specimens examined: McHenry Co. Ringwood, no date, G. Vasey; Ogle Co. Byron, 1885, Blount; Winnebago Co. Fountaindale, no date, M. S. Bebb; Rockford, March 30, 1910, J. G. Mosier; prairies, Rockford, April 16, 1940, April 19, 1940, G. D. Fuller (NHS).

Anemone canadensis L. Syst., Ed. 12, 3, App.: 231, 1768; Gleason (1910) 155; Britton and Brown (1913) 2: 99; Gates (1922) 167; Fuller (1925) 102; Gates (1926) 228; Pepoon (1927) 311; McDougall and Liebtag (1928) 228; McDougall (1936) 105; Jones (1942) 71; Fuller (1943) 94; Jones (1945) 131; Fuller (1946) 56.

A. pennsylvanica L. Mant. 2: 247, 1771; Beck (1828) 115; Mead (1846) 35; Forbes (1870) 352; Greene (1870) 6; Babcock (1872) 20; Patterson (1874) 1; Schneck (1876) 514; Higley and Raddin (1891) 2; Huett (1879) 43; Snare & Hicks (1898) 1.

Type locality: "Hab. in Pennsylvania."

Range: Lab.—Que.—Alta.—Colo. —Mo.—Md.

Stem 2-6 dm. tall, branching at the involucre, sparingly pubescent. Basal leaves long petioled, hairy, 3-5 lobed, the lobes dentate. Involucral leaves 3, sessile; secondary involucre often present. Flowers on long naked peduncles. Sepals 4-6, obovate, white. Head of achenes globose. Achenes pubescent, winged, style persistent, as long as or longer than the achene. Meadow Anemone.

Woods and moist places, northern and central Illinois.

A. dichotoma L., a Siberian species, closely resembles *A. canadensis*, differing from the latter in its narrower, oblong leaf segments and

glabrous, ovate achenes. Brendel (1887) 43, attributes *A. dichotoma* to the Peoria region; an examination of one of his specimens so labeled shows it to be *A. canadensis*.

Specimens examined: Adams Co. Bottoms around Big Lake, 3 miles south of Quincy, May 29, 1943, Rev. Brinker (NHS). Bureau Co. Normandy, May 29, 1946, Boewe (NHS). Calhoun Co. Low swales, Pepoon and Barrett, May 30, 1932 (NHS). Cass Co. Moist field, Meredosia, June 7, 1942, G. D. Fuller. Champaign Co. Without definite locality, June 28, 1886, M. B. Waite; woods, Urbana, June 5, 1900, Clinton; forest border, Urbana, July 26, 1928, McDougall; roadside, east of Urbana, May 24, 1929, S. J. Ewer; edge of thicket near Urbana, June 6, 1940, G. N. Jones; Sangamon River, near Mahomet, July 20, 1940, G. N. Jones; without definite locality, Gregory, No. 14002. Christian Co. Taylorville, 1887, DeMotte; Taylorville, no date, DeMotte; "Half Acre," Taylorville, May 22, 1897, W. Andrews. Cook Co. Damp ground, DesPlaines valley, May 25, 1896, A. Chase. Du Page Co. Wheaton, no date, Moffatt; Naperville, May 30, 1915, Keinholz. Ford Co. Moist ground near Paxton, May 29, 1940, G. N. Jones. Hancock Co. Cedar Glen, July 26, 1917, F. C. Gates. Henry Co. Damp meadows, Galva, June 1883, McDonald; prairie roadside near Galva, May 24, 1908, V. H. Chase; roadside south of Kewanee, May 29, 1946, Boewe (NHS). Jo Daviess Co. Apple River Canyon State Park, June 17, 1943, G. N. Jones, G. D. Fuller (NHS). Kankakee Co. Open woods and thickets, May 31, 1873, E. J. Hill; St. Anne, June 16, 1940, G. N. Jones. Kendall Co. Roadside north of Lisbon, May 28, 1946, Boewe (NHS). La Salle Co. Starved Rock State Park, June 5, 1939, D. T. Ries (NHS), May 27, 1939, F. G. Werner (NHS). Lake Co. Beach region north of Waukegan, June 16, 1909, F. C. Gates. Lee Co. Roadside south of Dixon, May 27, 1946, Boewe (NHS). Logan Co. West of Lincoln, June 18, 1930, L. R. Tehon; along Route 10 near Logan-DeWitt Co. line, May 29, 1946, Boewe (NHS); roadside near New Holland, May 29, 1946, Boewe (NHS). Macon Co. Damp woods east of Decatur, May 30, 1915, I. W. Clokey. Madison Co. Cahokia bottom, May 13, 1916, Drushel. Mason Co. Lake Matanzas, July 23, 1910, F. C. Gates. McHenry Co. Algonquin, June 14, 1878, Nason. Ogle Co. Oregon, July 8, 1882, M. B. Waite; White Pines Forest State Park, May 30, 1942, May 24, 1942, A. L. Hills. Peoria Co. Damp ground, Peoria, June 1889, McDonald. Stark Co. Clay bank north of Wady Petra, May 29, 1897, June 9, 1907, V. H. Chase. Wabash Co. Shannon's swamp, Mt. Carmel, July 21, 1882, Schneck. Winnebago Co. Above Rockford, July 23, 1933, Pepoon and Barrett (NHS).

Anemone caroliniana Walt., Fl. Car. 157: 1788; Lapham (1857) 500; Brendel (1859) 586; Patterson (1874) 1; Boltwood (1880) 71; Higley & Raddin (1891) 1; Huett (1897) 43; Robinson & Fernald (1908) 401; Gleason (1910) 155; Britton & Brown (1913) 2: 98; Pepoon (1927) 308; Jones (1945) 131.

A. tenella Pursh, Fl. Am. Sept. II: 387, 1814; Beck (1828) 115.

Type locality: "Carolina."

Range: Wis.—S. D.—Tex.—Fla.—N. C.

Perennial from a short thick rhizome. Stem 8-20 cm. tall, sparingly pubescent, stout. Leaves 3-divided; basal leaves petioled, often much toothed; stem leaves sessile. Sepals 6-20, bluish or white, pubescent outside, glabrous within. Achenes villous, in a cylindrical head. Carolina Anemone.

Bluffs and open places, central and northern Illinois. Rare.

This species may be confused with *A. decapetala* Ard. of more southern distribution. In the latter species the basal leaves are merely crenate. It is doubtful that *A. decapetala* occurs in Illinois. Brendel (1887) 43, cites it as occuring in the Peoria region. An examination of Brendel's specimen shows it to be *A. caroliniana*.

Specimens examined: Henderson Co. Banks of Mississippi River near Oquawka, May 18, 1873, Patterson. LaSalle Co. Sandy field, Utica, April 27, 1941, G. D. Fuller. Lee Co. Bank of Rock River, Dixon, May 21, 1860, E. J. Hill. Macon Co. Blue Mound, May 4, 1901, Andrews. Mason Co. Havana, April, 1942, T. H. Frison (NHS). Peoria Co. Dry gravelly slopes near Peoria, Apr. 1900, Apr. 1903, F. E. McDonald; Peoria, no date, Brendel. St. Clair Co. Mascoutah, no date, W. Welsch.

Anemone cylindrica A. Gray, Ann. Lyc. N.Y. III: 221, 1836; Lapham (1857) 500; Bebb (1860) 183; Greene (1870) 6; Babcock (1873) 248; Patterson (1876) 1; Brendel (1887) 43; Higley & Raddin (1891) 1; Huett (1897) 43; Snare & Hicks (1896) 1; Gleason (1910) 155; Gates (1912) 359; Sampson (1921) 563; Fuller (1925) 8; Thone (1925) 100; Pepoon (1927) 311; McDougall (1936) 104; Deam (1940) 461; Fuller (1943) 94; Jones (1945) 131; Fuller (1946) 56.

Type locality: "In dry pine barrens, near Oneida Lake, New York."

Range: Que.—B.C.—Ariz.—Kan.—Ill.—Pa.

Perennial. Stem 2-6 dm. tall, pubescent, branching above, stout. Leaves on long petioles, 3-divided, the divisions toothed above the middle; teeth obtuse to acute; leaf divisions cuneate. Involucral leaves 3-18. Flowers several, on long peduncles. Achenes villous, tipped with the minute styles, borne in a cylindrical head 2.5 cm. or more long. Candle Anemone.

Open woods, central and nothern Illinois, common.

Specimens examined: Champaign Co. No definite locality, June 22, 1876, Savage; no definite locality, June 19, 1896, M. B. Waite; Urbana, June 28, 1886, M. B. Waite. Cook Co. Sandy woods, South Chicago, July 9, 1875, E. J. Hill; sandy woods, Evanston, June 15, 1896, A. Chase; sunny woods, Evanston, June 15, 1896, A. Chase; dry field, Evanston, June 17, 1896, A. Chase; Rogers Park, August 16, 1896, Moffatt; near Addison, August 12, 1938, J. C. Carter (NHS). Du Page Co. Railroad east of Andrews, June 18, 1937, R. J. Dobbs (NHS). Kankakee Co. Dry woods near Waldron, July 10, 1873, E. J. Hill; barrens near St. Anne, June 12, 1932, Pepoon & Barrett (NHS). Lake Co. Beach region north of Waukegan, June 29, 1908, F. C. Gates; along Lake Michigan, Waukegan, Aug. 18, 1906, Gleason & Shobe; Libertyville, Sept. 7, 1912, E. Sherff. LaSalle Co. Starved Rock State Park, No. 137, Thone. Macoupin Co. Carlinville, June 7, 1880, Robertson (NHS). McHenry Co. Algonquin, July 13, 1878, June 21, 1878, Nason. McLean Co. Prairie, Normal, July 18, 1881, Seymour. Ogle Co. Gales Hill, Oregon, July 7, 1885, M. B. Waite. Peoria Co. Open woods, Peoria, June 18, 1889, F. E. McDonald; Peoria, no date, Brendel; dry slopes, Peoria, July 1903, F. E. McDonald. St. Clair Co. Mascoutah, no date, W. Welsch. Winnebago Co. Rockford, June 13, 1940, July 12, 1940, G. D. Fuller (NHS); west of Shirland, June 10, 1946, E. W. & G. B. Fell.

Anemone virginiana L. Sp. Pl. 540, 1753; Beck (1828) 115; Mead (1846) 35; Babcock (1872) 20; Patterson (1874) 1; Schneck (1876) 514; Brendel (1887) 43; Higley & Raddin (1891) 1; Gleason (1910) 155; Gates (1912) 359;

Fuller (1925) 8; Pepoon (1927) 311; Jones (1942) 71; Fuller (1943) 94; Jones (1945) 131; Fuller (1946) 56.

Type locality: "Habitat in Virginia."

Range: Que. — S. C. — Kan. — Wyo.—Alta.

Stem pubescent, 5-9 dm. tall, branching at the involucre. Basal leaves long petioled, 3-divided, the divisions toothed to below the middle, the margins serrate; divisions ovate to ovate lanceolate. Involucral leaves 3, short petioled. Flowers on long naked peduncles, sepals 5, white. Achenes villous, tipped by the subulate style. Head of fruit oblong, 1.8 to 2.5 cm. long. Virginia Anemone.

Woods and moist places; the commonest species in Illinois.

Specimens examined: Adams Co. Woods near Coe Springs, August 15, 1941, R. Evers (NHS); Fall Creek Gorge, July 19, 1941, Evers & Jones, No. 633, No. 675. Boone Co. Shady bank of slough northwest of Belvidere, June 14, 1946, E. W. & G. B. Fell. Carroll Co. Wooded hillside, Savana, July 12, 1902, A. Chase. Champaign Co. Urbana, July 15, 1886, M. B. Waite; Urbana, Oct. 1898, "GPC"; railroad, Seymour, July 5, 1928, McDougall; Sangamon River near Mahomet, July 20, 1940, G. N. Jones. Christian Co. Taylorville, June 19, 1889, June 25, 1899, June 26, 1897, Andrews. Coles Co. Fox Ridge State Park, Sept. 16, 1939, G. N. Jones, Aug. 21, 1941, Rennels (NHS); open woods near Charleston, Sept. 9, 1946, G. N. Jones. Cook Co. Washington Heights, June 1884, Moffatt; woods, Prospect Park, August 1887, Moffatt; woods, Glen Ellyn, June 20, 1894, Moffatt; damp woods, River Forest, July 7, 1896. A. Chase; wooded banks of Des Plaines River, Maywood, Sept. 9, 1900, A. Chase; woods, Thornton, July 14, 1902, Lansing. Fayette Co. St. Elmo, July 10, 1943, O'Dell; woods south of Ramsey, July 27, 1941, O'Dell. Franklin Co. Near Christopher, July 6, 1940, G. N. Jones. Jo Daviess Co. Apple River Canyon State Park, June 17, 1943, G. D. Fuller (NHS). Kane Co. Clearings, Elgin, Sept. 22, 1912, E. Sherff. Kankakee Co. Woods and thickets, Durham's Grove, July 18, 1873, E. J. Hill; woods and thickets, Kankakee, July 8, 1873, E. J. Hill. Knox Co. Wooded hills near Williamsport, July 5, 1908, V. H. Chase. Lake Co. Channel Lake, Antioch, Aug. 14, 1906, Gleason & Shobe; beach region north of Waukegan, July 19, 1909, F. Gates. Lee Co. North of Prairieville, Oct. 31, 1945, Boewe (NHS). McHenry Co. Algonquin, July 5, 1878, Nason. Ogle Co. Oregon, July 18, 1882, M. B. Waite. Peoria Co. Dry open woods north of Princeville, July 21, 1898, V. H. Chase; rich woods, Peoria, no date, McDonald; Peoria, no date, Brendel. St. Clair Co. Valley twp. July 6, 1895, V. H. Chase. Vermilion Co. Woods, June 24, 1880, Seymour & Butts; along Vermilion River between Oakwood and Collison, July 14, 1940, G. N. Jones. Wabash Co. Walter's Farm, Mt. Carmel, June 30, 1878, Schneck; woods, Mt. Carmel, Sept. 15, 1888, Schneck. Winnebago Co. Woods and meadows, Rockford, June 24, 1940, G. D. Fuller (NHS); bank of Kishwaukee River, June 4, 1946, E. W. & G. B. Fell.

Anemone quinquefolia L. Sp. Pl. 541, 1753; McDonald (1890) 105; Fuller (1925) 8; Pepoon (1927) 311; Jones (1945) 131; Fuller (1946) 56.

A. nemorosa sensu Mead (1846) 35; Lapham (1857) 500; Warne (1870) 314; Babcock (1872) 20; Patterson (1876) 1; Schneck (1876) 514; Brendel (1887) 83; Higley & Raddin (1891) 2; Huett (1897) 43; Snare & Hicks (1898) 1; not L. (1753).

A. nemorosa var. quinquefolia A. Gray, Man. Ed. 5, 38, 1867; Higley & Raddin (1891) 2.

A. quinquefolia var. interior Fern., Rhodora 37: 260, 1935; Deam (1940) 460.

Type locality: "Habitat in Virginia, Canada."

Range: Que.—Man.—Iowa—Ohio.

Stem simple, 1-2 dm. tall. Stem leaves 3, petioled, 3-divided, toothed. Basal leaf solitary, on a long petiole, trifoliolate, appearing after the flower. Stem glabrous or pubescent. Flower solitary. Sepals 4-7, ovate, white. Head of achenes globose; achenes few to several, not wing margined, tipped with the recurved style. American Wood Anemone.

Moist woods, northern Illinois; not common.

Fernald (1935) describes as var. *interior* specimens from the Great Lakes region in which the stems are spreading villous. In a study of Illinois specimens variation from almost glabrous to spreading pubescent and spreading villous was found. Specimens of the same collection number showed similar variation. Although some specimens might be referred to the variety, the variability in the amount and type of pubescence indicates that no clear distinction can be made between *A. quinquefolia* and its variety *interior* in Illinois.

Specimens examined: Cook Co. Rich woods, Hog Island, May 3, 1876, E. J. Hill; sandy woods, Hyde Park, April 20, 1878, E. J. Hill; Grand Crossing, May 3, 1883, Schneck; Prospect Park, May 11, 1890, Moffatt; sandy soil, Evanston, April 28, 1897, A. Chase; River Forest, May 4, 1897, A. Chase; woods, Evanston, May 7, 1897, A. Chase; rich woods, Edgebrook, May 11, 1897, A. Chase; Leyden, April 28, 1906, F. C. Gates; moist rich woods, Thornton, May 20, 1944, G. D. Fuller (NHS). DuPage Co. Thicket north of Wheaton, no date, Moffatt; Naperville, April 26, 1915, Kienholz; rich oak woods, Wheaton, April 19, 1938, G. D. Fuller (NHS). Jo Daviess Co. No definite location, no date, Brendel; Apple River Canyon State Park, May 6, 1944, G. N. Jones. Kankakee Co. Open woods, Kankakee, May 17, 1873, E. J. Hill. LaSalle Co. Starved Rock State Park, May 6, 1939, Werner, May 4, 1939, D. T. Ries (NHS). McHenry Co. Algonquin, no date, A. L. Hills. Will Co. Rich woods, Mokena, May 7, 1902, A. Chase. Winnebago Co. Margin of woods, Rockford, May 14, 1940, G. D. Fuller (NHS).

Excluded Names

Anemone hepatica L. Sp. Pl. 538, 1753; Mead (1846) 35; Higley & Raddin (1891) 2.

This species is now designated *Hepatica americana* (DC.) Ker.

Anemone acutiloba (DC.) Laws. Trans. Nov. Scot. Inst. III: 30, 1870. Higley & Raddin (1891) 2.

This species is also referred to the genus *Hepatica*, as *H. acutiloba* DC.

Anemone thalictroides L. Sp. Pl. 542, 1753; Beck (1828) 115.

This species is now considered as *Anemonella thalictroides* (L.) Spach.

Summary

The six species of the genus Anemone in Illinois have been studied. Anemone is found throughout the state. In northern and central Illinois all six species are represented; in southern Illinois are found one *(A. virginiana)* or possibly two *(A. cylindrica)* species. Additional collections are needed to establish the range of these two species in Illinois. Four of the species *(A. canadensis, A. virginiana, A. cylindrica,* and *A. quinquefolia)* are typically found in woodlands and moist places. Two species of dry ground and prairies *(A. caroliniana* and *A. ludoviciana),*

both rare, occur in northern and central Illinois.

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THINNING RETURNS FROM AN EASTERN WHITE PINE PLANTATION IN OGLE COUNTY

RALPH W. LORENZ
University of Illinois, Urbana

Early thinnings that can be made to pay their way or show a profit will put the management of forest plantations on a sound basis. As a general rule, thinning is usually delayed until the financial return will equal the expense of performing the operation. In plantation management the original spacing should be so chosen as to allow for proper development of planted trees without excessive competition with one another up to an age and size which will permit a profitable thinning. Utilization practices within a given area will determine the spacing. Even though not immediately profitable, early thinnings may be justified on the basis of over-all stand improvement and the fact that they will increase the increment of quality wood on pruned crop trees. It has been proved that the increment on pruned trees will return a profit at the time of harvest. Since a group of relatively few trees of large diameter on an area will yield much more lumber than numerous trees of small diameter, the advantage of concentrating growth on a small number of trees is evident. Forty-seven percent of the total yield and 35 percent of the total value of a pine-spruce stand in central Sweden was removed in the form of thinnings (3).

Four one-quarter acre permanent sample plots were established in a 32-year-old white pine plantation on Sinnissippi Forest, Ogle County, in 1939. These plots serve for thinning and pruning studies. Periodic measurements provide growth and yield information. The first thinning was made in the fall of 1941 at the age of 34. An earlier thinning would have resulted in better development and increased growth of the final crop trees. A second thinning was made in the fall of 1946 at the age of 39. Stand conditions before and after thining, together with material removed, are summarized in Table 1. In two plots the desired stocking was reduced by a severe wind storm, a plane crash and the death of several crop trees. Although the primary cause of death was not determined, the red-turpentine beetle *Dendroctonus valens*, was always associated with the dying trees.

The main purpose of the thinnings was to provide the pruned crop trees with sufficient growing space for their optimum development. Trees removed were principally in the codominant crown class with some in the dominant. Diameter growth of the intermediate-crown class was low, and the suppressed trees showed no growth for the five-year period. The suppressed trees were removed if large enough to yield a post. Their small undeveloped crowns aided little in site protection.

Sinnissippi Forest operates its own sawmill and a semicommercial treating plant for the preservation of fence posts (2). Some 2 to 3 thousand fence posts are treated annually. They are cold-soaked 48 hours in a 5-percent solution of pentachlorphenol in light fuel oil. The financial success of these thinnings was largely due to the ready sale of treated posts and rough lumber at near-by markets. Lumber and treated fence posts are retailed at the mill yard. Special orders are

TABLE 1—COMBINED DATA FOR FOUR ONE-QUARTER ACRE PLOTS
Eastern White Pine Thinning and Pruning Plots
Sinnissippi Forest, Ogle County

Age	Trees per acre	Basal area	Av. Height		Site index	Av. D. B. H.		Diam. range	Stand density	Volume per acre[a]	
			All trees	Dom. and codom.		All trees	Dom. and codom.			Trees 2" and over	Trees 8" and over
Years	No.	Sq. ft.	Feet	Feet	Feet	Inches	Inches	Inches	Index	Cu. ft.	Bd. ft.
					Stand before thinning						
34	636	181	42	46	72	7.2	8.2	3-15	375	3942	13,665
					Material removed in thinning						
34	148	38	40	..	..	6.9	...	3-12	...	821	2,742
					Stand after thinning						
34	488	143	43	46	72	7.3	8.2	4-15	294	3121	10,923
					Stand before thinning						
39	452	161	49	53	70	8.2	8.9	3-16	329	3937	17,869
					Material removed in thinning						
39	132	30	44	..	..	6.5	...	3-14	...	683	1,746
					Stand after thinning						
39	320	131	51	53	70	8.7	8.9	4-16	256	3254	16,123

[a] Volumes from Harvard Forest Bulletin No. 13, Form class 65.

TABLE 2.—POST AND LUMBER YIELDS FROM FOUR ONE-QUARTER ACRE SAMPLE PLOTS

Plot No.	Select		No. 1		No. 2		Total		Board feet[a]	
	Age 34	Age 39	Age 34	Age 39	Age 34	Age 39	Age 34	Age 39	Age 34	Age 39
113	7	15	64	94	28	41	99	150	476	355
114	5	16	43	94	19	51	67	161	142	205
115	10	8	91	51	39	23	140	82	486	135
116	6	6	56	39	24	15	86	60	530	166
Per acre	28	45	254	278	110	130	392	453	1,634	861

[a] International log rule (sawkerf ¼ inch).
Post specifications: Minimum top D.I.B. of 6 inches for select, 4 inches for No. 1 and 3½ inches for No. 2.

delivered to Oregon and Rockford markets. Data on cost of growing these pine plantations with expected returns were published in 1944 (1).

All posts were graded for this study. The choice of post grades was arbitrary, although selected from the standpoint of farm demand. Lumber and post yields, together with specifications by grades, are listed in Table 2. In 1941 all graded posts were sold in mixed lots for 55 cents each. In 1946 they were sold by grade only. Select, No. 1 and No. 2 grades sold for 85, 75 and 65 cents respectively. The rough pine lumber was sold largely in the form of two-by-fours and inch boards. One specific order included finished knotty-pine boards for interior decoration.

Table 3 illustrates the method used to figure net stumpage appraisals for treated posts and lumber.

TABLE 4.—THINNING YIELDS AND NET STUMPAGE RETURNS PER ACRE

Age 34	391 fence posts @ 10c.	$ 39.10
	1,634 bd. ft. @ $23.00/M	37.58
	Total	$ 76.86
Age 39	453 fence posts @ 20c.	$ 90.60
	861 bd. ft. @ $37.00/M	31.86
	Total	$ 122.46
Total net stumpage returns		$ 199.14

The light sandy soils supporting these pine plantations are considered too poor for general farm use. Therefore, the total net stumpage returns of $199.14 per acre from these two thinnings is very encouraging from the standpoint of plantation management. It is possible that all costs of raising these pine plantations, including 3 percent compound interest, may be entirely liquidated by the next thinning.

TABLE 3.—STUMPAGE APPRAISALS FOR TREATED POSTS AND LUMBER
Eastern White Pine Thinning and Pruning Plots
Sinnissippi Forest, Ogle County

	Age 34 in 1941		Age 39 in 1946	
Average selling price per post		$.550		$.720
Production costs				
Cutting	$.101		$.136	
Peeling	.094		.138	
Hauling	.020		.015	
Treating solution	.120		.116	
Treating labor	.025		.019	
Equipment and depreciation	.015		.010	
Total of direct cost and depreciation	.375		.434	
Plus 20% of cost for profit and risk	.075		.087	
Total cost and margin		.450		.520
Indicated stumpage value per post		.100		.200
Average mill-run selling price				
1,634 bd. ft. at $65.00 in 1941		$106.21		
861 bd. ft. at $85.00 in 1946				$73.18
Logging and milling cost plus depreciation	$57.19		$34.44	
Plus 20% of cost for profit and risk	11.44		6.89	
Total cost and margin		68.63		41.33
Indicated stumpage value		37.58		31.86
Indicated stumpage value per M		23.00		37.00

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INITIAL REPORT ON THE VEGETATION OF McDONOUGH COUNTY, ILLINOIS[1]

R. MAURICE MYERS AND PAUL G. WRIGHT
Western Illinois State College, Macomb, and High School, Carthage

McDonough County is located in the west-central part of the state. It originally included 16 townships of approximately equal area (it now has 18) and has an area of 576 square miles. According to Hopkins et al. (1913) the elevation ranges from 500 to 775 feet above sea-level with an average of 690 feet. The greater part of the county is drained through the Lamoine River and its branches into the Illinois River. The principal streams extend in almost parallel lines toward the southwest. This part of the county is considerably dissected by erosion and is least suited to ordinary agriculture. Most of the county is covered with glacial drift from 10 to 140 feet thick, and considerable areas in the northern part are capped with loess up to 50 feet thick. Hopkins et al. (1913) have divided the soils into three main types: dark upland prairie soils, swamp and bottomland soils, and lighter colored upland timber soils. The average rainfall is 34.76 inches (Hambidge, 1941).

McDonough County, according to the geographic classification of Shelford (1931), is in the Macomb District of the Western Division of Illinois. In a map of the vegetation of the state Vestal (1931) showed that somewhat more than half of the county was originally prairie. The prairie, called the Bushnell Prairie, extended west into Warren and Henderson counties. Wright (1947) made a study of McDonough County prairies.

[1] The authors wish to acknowledge the invaluable assistance of R. M. Sallee of the biology department of Western Illinois State College, and that of George D. Fuller of the University of Chicago and the Illinois State Museum for checking the identification of most of the plants collected.

Methods Used in Studying the Vegetation

To reconstruct a picture of the original vegetation the following were consulted: (1) Histories of the county (Walters, 1885, and Alexander, 1907); (2) records of the land survey of the county which were completed in 1856; (3) report of the soils survey of the county (Hopkins et al. 1913). Field observations were also made.

Only limited observations have been made in all parts of the county. The most extensive reconnaissance and collecting were done in the central part where a timbered area with a minimum amount of disturbance and a relic area of prairie were studied. Very few records of plants collected in the county have been found and there is no adequate description of the flora. Miller and Tehon (1929) have mapped the distribution of the trees in the state by counties. They list only 10 trees for McDonough County. A herbarium has been started and is being developed with the objective of securing specimens and habitat data for all existing plants in the county. Duplicates are being sent to the Illinois State Museum.

Original Vegetation

The land survey of 1856 prepared manuscripts which give an apparently accurate picture of the vegetation at that time. The surveyors divided the county into townships and further subdivided it into sections and quarter sections. The corners of these divisions were located by posts in treeless areas and with

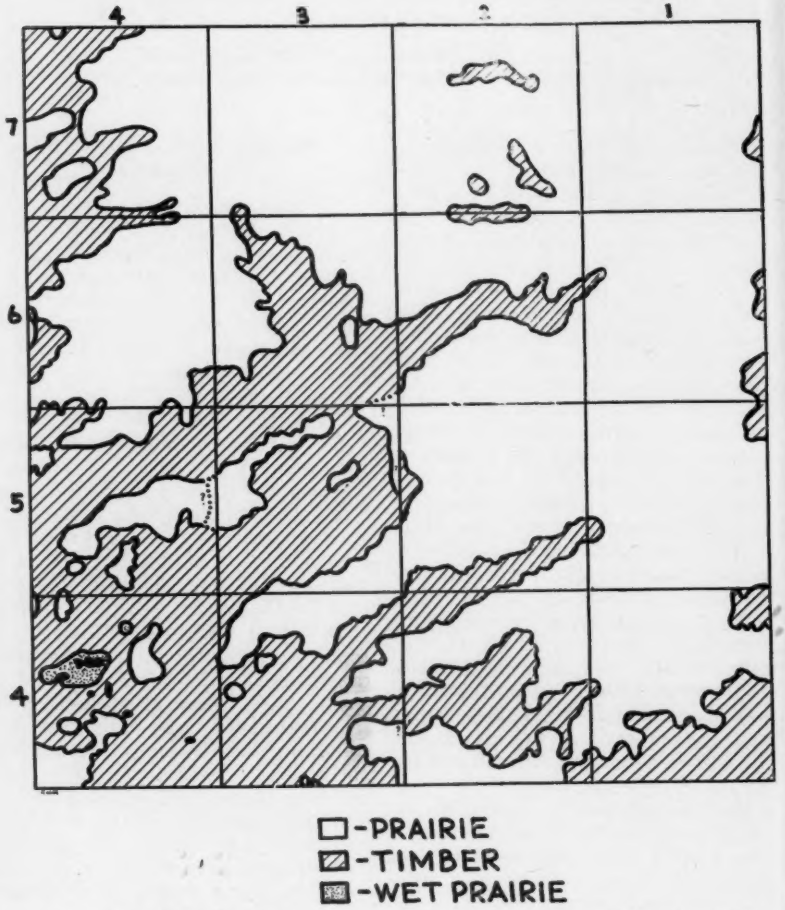

FIG. 1.—Prairie and timber areas of McDonough County as shown by 1856 survey records.

reference to trees in the timbered regions. The records include the species of trees, their diameter and their location. Sixteen species of trees were listed. The areas of timber and prairie were mapped for each township and then a composite map for the entire county was made. Some apparent errors were found for instance Spanish oak was listed, and this now occurs only in the southern part of the state, and the boundaries of the vegetation types do not always coincide for adjacent townships. A map made from these data is shown in figure 1.

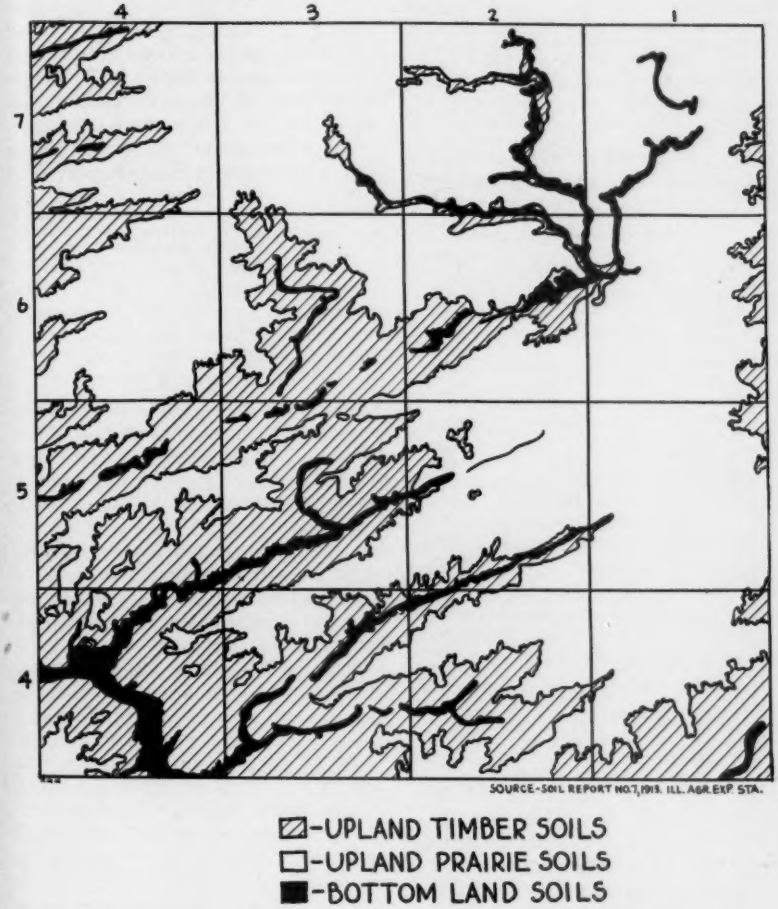

FIG. 2.—Distribution of timber, prairie, and bottomland soils of McDonough County. (Compare with fig. 1.)

Another map of the county was constructed based on the soils map of the county (Hopkins et al. 1913) to show the distribution of timber, prairie and bottomland soils (fig. 2). There is a close correlation with the map made by the 1856 surveyors. A less detailed map was made by Vestal (1931) from the same data for the entire state.

Some idea of the relative abundance of important tree species perhaps can be obtained by tabulating the number of times that a tree was listed in locating corners of the county divisions. The trees in Township 6 North and 3 West (Emmett) listed most often by the surveyors were white oak (49 times) and black oak (47 times) and other species

were listed altogether only 33 times. Table 1 gives a complete tabulation of all the trees listed. The present distribution of trees in this township is quite similar.

TABLE 1.—NUMBER OF TIMES THAT CERTAIN TREES WERE LISTED IN LOCATING SECTION CORNERS IN T. 5 N., R. 4 W. (EMMETT)

White oak	49
Black oak	47
Hickory	15
Elm	6
Birch	3
Black Jack oak	2
Spanish oak (?)	1
Black walnut	1
Sugar tree	1
Maple	1
Buckeye	1
Mulberry	1
Linden	1

Township 4 North and 4 West (Lamoine) contains a considerable area of low lying land and in 1856 was mapped as containing four lakes and two areas of wet prairie as shown in figure 1. The trees listed by the surveyors indicate a wide distribution of pin oak. Pin oak was listed 32 times and white oak 59 times and black oak 27 times. Table 2 gives the complete tabulation.

TABLE 2.—NUMBER OF TIMES THAT CERTAIN TREES WERE LISTED IN LOCATING SECTION CORNERS IN T. 4 N., R. 4 W. (LAMOINE)

White oak	59
Pin oak	32
Black oak	27
Hickory	26
Overcup oak (?)	21
Maple	9
Elm	7
Red oak	2
Hackberry	2
Cottonwood	2
Buckeye	1
Cherry	1
Ironwood	1
Linden	1
Spanish oak (?)	1

T. 7 N., R. 3 W. (Sciota) was shown as containing only a small tongue of timber extending up from the southwestern edge. Only 7 trees were used in locating division corners (Table 3) and the survey records indicated that these were in the small areas mapped as timber. The

TABLE 3.—NUMBER OF TIMES THAT CERTAIN TREES WERE LISTED IN LOCATING SECTION CORNERS IN T. 7 N., R. 3 W. (SCIOTA)

Hickory	2
Pin oak	2
Black oak	1
White oak	1
Linden	1

boundaries of this timbered area are practically the same now as they were in 1856. The rest of the township contains only a few scattered trees in the vicinity of farmhouses.

A history of the county (Alexander, 1907) states that originally there was a "splendid growth of oak, maples and black walnut" and that the smaller trees included ironwood, wild cherry, wild plum and others. In describing the open prairies at the time of early settlement it says, "And how delightful to recall even the fleeting visions and memories of those primitive days; the rushes and lilies of the sloughs and ponds; the delicious wild strawberries; the yellow ground cherries and other wild fruits that bloomed or ripened in the prairies of this favored land, . . . the countless varieties of wild flowers that profusely decked and perfumed this home of early settlers. Truly what a flower garden and orchard this prairie country was, not excelled by the modern creations of horticulture and floriculture!" A list of more than 100 flowering plants was included. Most of these are still found, but no collections of skunk cabbage, white trillium, red-berried elder, certain orchids and gentians which were listed have been made.

Present Vegetation

According to Telford et al. (1926) the original timber area decreased from 119,001 acres to 22,460 acres by 1924. The prairie has almost entirely disappeared. A small area of prairie was found recently a few miles from Macomb which included many typical prairie plants. Most of the area is well drained, but some is swampy. It is burned over nearly every year, but the sod is not plowed. Bunch flower *(Melanthium virginicum)* and the fringed orchid *(Habenaria leucophaea)* both listed by Jones (1945) as rare in Illinois were found in considerable numbers. Table 4 is a list of some of the plants that were collected here. These were included by Sampson (1921) in his list of plants in Illinois prairies. Of the 52 plants, 40 are included in his *Andropogon furcatus* association. It is hoped to make a more complete study of this area. Shelford (1931) stated that, "cut-off prairies in the western part of the Macomb district seem to likewise afford promise for detailed study."

Table 4.—Some Prairie Plants Found in a McDonough County Prairie[1]

(See text for a fuller explanation)

Equisetum arvense—Horsetail
Andropogon furcatus—Tall blue stem
Sorghastrum nutans—Indian grass
Panicum virgatum—Switch grass
Calamagrostis canadensis—Reed grass
Spartina pectinata—Cord grass
Hordeum jubatum—Foxtail grass
Cyperus spp.—Cyperus
Eleocharis sp.—Spike rush
Carex spp.—Sedges
Tradescantia canaliculata—Spiderwort
Juncus spp.—Rushes
Lilium michiganense—Wild lily
Hypoxis hirsuta—Star-grass
Salix humilis—Prairie willow
Anemone canadensis—Meadow anemone
Heuchera hispida—Alum root
Fragaria virginiana—Wild strawberry
Rosa carolina—Wild rose
Baptisia leucantha—Wild indigo
Desmodium sp.—Tick clover
Oxalis violacea—Violet wood sorrel
Euphorbia corollata
Viola papilionacea—Common blue violet
V. pedatifida—Prairie violet
Lythrum alatum—Loosestrife
Eryngium yuccafolium—Rattlesnake master
Lysimachia ciliata—Fringed loosestrife
Apocynum cannabinum—Hemp dogbane
Asclepias tuberosa—Butterfly-weed
A. syriaca—Common milkweed
A. verticillata—Horsetail milkweed
Phlox glaberimma—Smooth phlox
Lithospermum canescens—Gromwell
Monarda fistulosa—Bergamont mint
Pycnanthemum flexuosum—Mountain mint
Ruellia ciliosa—Wild petunia
Lobelia spicata—Lobelia
Vernonia missurica—Ironweed
Liatris sp. Blazing star
Solidago spp.—Goldenrods
Aster spp.—Asters
Silphium lacinatum—Compass plant
S. terebinathinaceum—Prairie dock
S. integrifolium—Rosin-weed
Parthenium integrifolium—American feverfew
Echinacea pallida—Pale coneflower
Ratibida pinnata—
Helianthus grosseratus—Sunflower
Coreopsis palmata
Cacalia tuberosa—Indian plantain

[1] The nomenclature of Jones (1945) is followed in this paper.

About five miles west of Macomb in T. 5 N., R. 4 W. (Emmett) is a rugged timbered area called Argyle Hollow. Some of it has been heavily pastured and all of it has been cut-over. More than 1,000 acres are being acquired by the state for a park. Extensive reconnaissance and collecting has been done in the least disturbed areas as much of it will be inundated by a lake to be built soon. The dominant trees of the uplands are white and black oaks *(Quercus alba, Q. velutina)* and shagbark hickory *(Carya ovata)*. Associated species include bur, post, black jack and shingle oaks *(Quercus macrocarpa, Q. stellata, Q. marilandica, Q. imbricaria)*, and pignut hickory *(Carya glabra)*. At the lower part of the ravines are sugar maple *(Acer saccharum)*, elms *(Ulmus americana, U. fulva)*, river birch *(Betula*

nigra), buckeye *(Aesculus glabra)*, and yellowbud hickory *(Carya cordiformis)*. The underlying herbs include trout lily *(Erythronium americanum)*, Dutchman's breeches *(Dicentra cucularia)*, bellwort *(Uvularia grandiflora)*, phlox *(Phlox divaricata)*, several ferns including the very common brittle fern *(Cystopteris fragilis)*, maiden hair fern *(Adiantum pedatum)*, broad beech fern *(Phegopteris hexagonaptera)*, ebony spleenwort *(Asplenium platyneuron)*, and many others. The present trees are similar in their distribution to that given by the surveyors in 1856 (Table 1).

Summary

1. The original and present vegetation of McDonough County, Illinois, is described. Data were secured by field observations, from histories of the county, from the survey records of 1856 which included maps of the timbered and prairie areas and lists of species of trees, and from soils maps. There was a close correlation between the soils of the county and the vegetation map of 1856.

2. A list of 52 prairie plants found in a relic area of prairie is given; 40 of these have been included by Sampson (1921) in the *Andropogon furcatus* association.

3. The distribution of common plants in a timbered area is described.

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CHEMISTRY

THE DYSONIAN SYSTEM OF ORGANIC NOTATION

C. W. BENNETT
Western Illinois State College, Macomb

In the spring of 1947, G. M. Dyson, an English chemist, presented his new linear system of organic notation before the American Chemical Society. It was reviewed in The Chemical and Engineering New[1,2] and in the Journal of the American Chemical Society[3]. Soon thereafter, Dyson published a small book[4] giving more complete detail. He is not especially interested in superseding the present systems such as the Geneva but rather to make codification on punched cards more simple. Perhaps this is only a passing fancy, but it is so logical, so simple, and so useful that it may indeed be generally adopted. Therefore, it seems that every informed chemist should be conversant with it. In an address before the American Chemical Society in April 1948, Dyson related that he had made some changes which would appear in his revised edition.

In common with most English writers, his language is not as simple as we Americans are accustomed to. He uses the term "modulant" to refer to the number of atoms in groups. This is a full sized number (not a subscript or superscript) following the symbol such as C8 which implies a straight chain of eight carbons with the full number of hydrogens, which, of course, is understood. C8 is, therefore, n-octane, C_8H_{18}. The term "locant" refers to a number which precedes the group and gives its position in the system. Thus in C7.3C2, 7 and 2 are modulants and tell how many carbons; while 3 is a locant and tells where the C2 (ethyl group) is located in the seven carbon chain (heptane). C7.3C2 is, therefore, 3-ethyl heptane. Similar substituents on the same chain are numbered as in the Geneva system but without using any equivalent for di-, tri-, tetra-, etc. Thus C9.3,5C2 is 3,5-diethyl nonane. The largest branches are listed in decreasing size.

A denotes saturated rings. (Previously Dyson used AC, but apparently A signifies as much as AC.) A6 would be cyclohexane, C_6H_{12}. He is revising all the ring ciphers so they will be omitted here except for benzene which he formerly wrote B but now seems to write B6. B suggests aromatic character.

E is used for double bonds, E1, cis; E2, trans; E3, triple bonds. C4.1,3E is butadiene and C5.2E3 would be 2-pentyne.

Q is used for -OH. Thus B6.1,3,5Q is 1,3,5-trihydroxy benzene, C3.2C.2Q is tertiary butyl alcohol. Ethers are ciphered as C4.Q(C2) which is n-butyl ethyl ether.

Since E means unsaturated, EQ is double bond oxygen as in aldehydes and ketones. C4.EQ is n-butyraldehyde, but C4.2EQ is butanone.

X denotes the =O and -OH of the carbonyl group. Thus C3.X is CH_3-CH_2COOH for propionic acid and B6.CX(C2) for the ester, ethyl benzoate.

N means amine as C4.N for n-butylamine; C3.NC2 is ethyl propyl

amine. Amides as C3.EQ(N) for propionamide.

N1 is nitroso; N2, nitro; then B6.N.4N2 means p-nitroaniline.

Halogens are shown by F, CL, BR, and I. B6.1,4I is p-di-iodobenzene. S and P with modifiers are used for those elements, sulfur and phosphorus respectively.

Carbohydrates are ciphered as C6.2 . . . 6QEQ.3L for d-glucose where 3L means that the third C has its -OH on the left. This may be shortened to G6.EQ.3L.

These do not begin to exhaust the varieties of conventions used but are presented here to give an idea of the system.

A very useful feature is the rapid method of calculating molecular formulas. The following is an abridged list of computing constants:

A	-2	N	1000001
B6	604	N2	1019999
C	102	Q	10000
E	-2	X	19998
E3	-4	Halogens	-1

The required numbers are added and pointed off two places at a time from the right to give the number of atoms of N, O, C, and H respectively reading from the left. Thus for:

B6.N:	B6	604
	N	1000001
	Add	2
		1000607
		N O C H
	C_6H_7N or	$C_6H_5NH_2$

B6.N.4N2:	B6	604
	N	1000001
	N2	1019999
	Add	2
		2020606
		N O C H
	$C_6H_6N_2O_2$ or	$C_6H_4NH_2NO_2$

Likewise the following would be calculated, for example:

C2.Q.2N:	C2	204
	Q	10000
	N	1000001
	Add	2
		1010207
		N O C H
	C_3H_7NO or	$H_2NC_2H_4OH$

C3.2E3.X:	C3	306
	E3	-4
	X	19998
	Add	2
		20302
		O C H
	$C_3H_2O_2$ or	$HC{\equiv}C\text{-}COOH$

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1. Chemical and Engineering News, March 24, 1947, p. 847.
2. Ibid. May 5, 1947, p. 1251.
3. Journal of the American Chemical Society. 69, p. 728. (1947).
4. Dyson, G. M. *New Notation and Enumeration System for Organic Compounds.* New York: Longmans, Green and Company, 1947, 63 p.

QUANTIZED QUALITATIVE ANALYSIS

W. P. CORTELYOU
Roosevelt College, Chicago

Description of the Course

This paper is a description of a course in the systematic qualitative analysis of a solution for cations. The course was given by the author for several years at Valparaiso University and has been given at Roosevelt College since the college was founded in the fall of 1945.

The scheme of analysis is a modification of one of the many H_2S schemes. It was first derived from the procedures of Arthur and Smith. Its difference lies mainly in that it provides for a quantitative report for each cation present.

The idea of quantitative reports in connection with qualitative analysis is by no means a new one but our method of handling them does appear to be new.

All unknowns are one per cent cation solutions. That is to say the total weight of the cations present is one per cent of the weight of the solution. Each solution has the concentration that would result if one gram of an alloy were dissolved in an acid and diluted to 100 ml.

It is important to note here that the concentration of the solution is not proportional to the number of cations present, as is recommended by many text book writers. By the method we recommend if several cations are present the concentration of each is lowered.

The student is given a 5-10 ml. sample of the unknown solution. He is directed to take exactly 1.0 ml of this solution as the basis for his analysis. This is usually measured with a pipet but a 10 ml. graduate is accurate enough if carefully used. The student is assured that this 1.0 ml. sample of the unknown contains just 10 mg. of total cations, certainly within the limits of 9.5 to 10.5 mg.

Furthermore, the student is assured that if more than one cation is present each will appear in even mg. units. For instance, one ml. of a solution containing Cu and Zn might contain 9 mg. of Cu and 1 mg. of Zn, or 8 mg. of Cu and 2 mg. of Zn, etc., but no quantities that would have to be expressed in fractions of mgs. per ml. This is the source of our title, "Quantized Qualitative Analysis." The different cations appear only in quanta without fractions just as radiant energy does.

Establishing this quanta rule is analagous to asking an analyst to find the major components in an alloy and determine the percentage present to within ten percent of the total. Any component making up less than about five percent of the total would be disregarded. It may also be considered as quantitative analysis to one significant figure.

The grade the student gets depends on how closely he comes in his report to the correct quantitative composition of the solution he analyzed. At first it might appear that this would involve too much concern on the part of the student and too great a burden in grading the reports. Actually neither of these things is true.

Consider a set of unknowns in the copper subgroup and some possible student reports on them:

Solutions	Cations					
	Hg	Pb	Bi	Cu	Cd	Grade
Unknown 1	0	50	0	50	0	
Report 1a	..	60	..	40	..	50+40=90
Report 1b	10	30	20	40	..	30+40=70
Report 1c	..	10	..	90	..	10+50=60
Unknown 2	20	30	30	10	10	
Report 2a	0	50	50	0	0	30+30=60
Report 2b	30	20	10	20	20	20+20+10+10+10=70
Report 2c	30	0	0	40	30	20+10+10=40

This system of grading has several characteristics.

(1) It is easy to use. The grade is obtained by comparing the composition and the report and adding together the smaller of the two figures appearing under each cation.

(2) Reporting ions not present or reporting them in excessive amounts is automatically penalized because then the student cannot report high enough percentages for the ions actually present. (See report 1b.)

(3) A student will get a fair mark if the qualitative part of his work is correct even though he misses the quantitative answer beyond all expectation. (See Reports 1c and 2b.)

(4) A student is not penalized so much for missing the minor components as for missing those present in large amounts. (See Reports 2a and 2c.)

The preparation of the unknown solution is a simple matter. Stock solutions of salts of the usual 24 cations are prepared. In each solution the concentration of the cation is one per cent (or 10 mg/ml). If the unknown is to contain only one cation, this stock solution also serves as the unknown. Other kinds of unknowns are made by mixing these stock solutions in the proper proportions without otherwise diluting them. For instance, a solution containing 4 mg. of Cu and 6 mg. of Zn per ml. would be made by mixing 4 ml. of the Cu stock solution with 6 ml. of the Zn stock solution. If a large number of unknowns are to be issued, it may be desirable to prepare more concentrated stock solutions from which the above mentioned dilute stock solutions can be prepared. Most soluble salts are soluble to the extent of 100 mg. of the cation per ml., but a few become saturated at a much lower concentration.

Some Details of the Analysis

To perform the analysis the student first makes the usual qualitative separations using standard semi-micro techniques. When a given cation has been isolated one of several different quantitative techniques is applied. Most of these involve comparison with standard solutions. These standard solutions are prepared by diluting the stock solutions referred to above by a ratio of 10 to 1. Thus the student always has access to a stock solution of each cation containing 1.0 mg. of the cation per ml., the minimum amount of that cation that could be present

in each unknown. If a large amount of the cation is present in the unknown, the amount will be a simple multiple of the amount in the standard.

The most common but most unsatisfactory method of estimating amounts is by comparison of precipitate volumes. Eleven of the 24 cations are handled in this fashion. They are Bi, Cd, As, Sb, Sn, Al, Zn, Ni, Mg, Na, K. For each of these that may be found present one mg. of the cation from one ml. of the stock is converted to the same precipitated compound as occurs in the course of analysis and the volumes of the two precipitates compared, usually after centrifuging. Some consideration has been given to the use of graduated centrifuge tubes but these have not been tried.

Amounts of Ag and Hg are estimated by nephelometry. For estimates to the first significant figure this does not require any special apparatus. The procedure is very simple. A 250 ml. beaker for the standard and a beaker of the same size for the unknown are placed over some reading matter. 200 ml. of distilled water is placed in each. The precipitating reagent is added to each beaker in equal amounts and a solution of the isolated cation is added to the unknown beaker. As soon as the fogginess produced by the precipitate has reached a maximum the standard solution is added to the standard beaker from a 10 ml. graduate, in 1 ml. units. The fogginess in the two beakers is compared by attempting to read the print through them. When enough standard has been added to match the fogginess of the unknown the volume of standard solution required is read from the graduate. This volume in ml. equals the number of mgs. of the cation in one ml. of the unknown solution.

Amounts of Cu, Cr, Mn, and Fe ions are estimated by measuring the intensity of the color produced by some form of the ion. Here again no special equipment is used. The volume of isolated cation solution which matches one ml. of the standard equals the number of mgs. of that cation in one ml. of the unknown.

The amount of Pb, Ba, or Sr is estimated by separating or precipitating it as a chromate, washing out the excess chromate reagent, dissolving the precipitate in HCl, and comparing the color formed with that produced in the same way from a one mg. standard.

Determining the amount of Co gives an opportunity to illustrate volumetric precipitation as a quantitative analysis technique. The Co is precipitated by alpha-nitroso-beta-naphthol and the number of drops of reagent required to complete the precipitation is determined. Three drops of the reagent precipitates 0.10 mg. of Co (not 1.0 mg.). This means 300 drops would be required to precipitate the maximum amount of cobalt that could be present. Therefore one-tenth of the isolated cation is tested. This requires from 3 to 30 drops. This illustrates the point that some tests are so sensitive that practical estimates in a reasonable time or reasonable volume can be made only by diluting the cation after it is isolated. Such dilutions are required in estimating Mn, Co, and Ni.

Ca is readily determined by an adaptation of the standard procedure in volumetric analysis where CaC_2O_4 is oxidized with $KMnO_4$. Of course, a sufficiently accurate estimate may be obtained by counting the drops of N/3 $KMnO_4$ solution required. As before from 3 to 30 drops will be used.

The amount of ammonium ion is readily obtained by treating one ml.

of the original solution with NaOH and distilling the NH_3 into cold water very much like the procedure in a semi-micro Kjeldahl determination. The number of drops of an HCl solution required to keep the distillate acidified is determined.

Some Reasons for Making Quantitative Reports

Nothing has been said thus far about the reasons for requiring students to make quantitative estimations in conjunction with qualitative analysis.

In the first place, if a student does not estimate quantities he too easily gets the impression that concentration has nothing to do with qualitative analysis, that it is possible to list all conceivable components as being simply "present" or "absent" in a given mixture. To be sure, the teacher who makes up the unknowns knows that the concentrations have to be watched rather carefully, but too often this information is withheld from the student.

Furthermore, it is usually customary to emphasize the principles of chemical equilibrium in the theoretical part of a course in qualitative analysis. Numerical calculations involving solubilities, solubility products, and ionization constants take up much of the time of the course. Most of the value of these calculations is lost if an attempt is made to apply them to solutions of unknown concentration. Likewise the typical student of qualitative analysis will have had only one or two semesters to practice calculations based on balanced chemical equations. He cannot get too much practice in quantitative thinking.

Reasons for Using One Percent Solutions

Some textbook writers recommend that stock solutions be made to a specified normality. To be sure this makes it easy to calculate equivalent quantities of reagents but it is completely unrealistic since it is obviously impossible for a practicing analyst to prepare an unknown solution so it will have a specified normality. However, an analyst faced with the problem of studying an unknown metal or alloy can prepare a one percent solution of this substance and that would seem to be the intelligent way to attack the problem.

The concentration recommended here, one percent total cations, is somewhat more dilute than is commonly used in semi-micro qualitative analysis but it gives good results. In normalities it gives a range of about 0.01 normal to 0.1 normal. It has proved advantageous to conduct many of the separations by adding 1.0 ml. of a 1.0 N solution of the required reagent. It will be seen that this is from ten to a hundred times the equivalent amount, yet the reagent itself is so dilute that a large excess does no harm to the solution. Thus it is often possible to eliminate time consuming procedures that require the student to add a reagent drop by drop until a reaction is complete.

Adjusting the acidity before precipitating the first sulfide group is a simple matter in one percent solutions. One ml. of the solution is diluted to 3 ml. and made neutral to litmus. Adding 1.0 ml. of 1 ON HCl makes the solution about 0.25 N acid, a good condition for precipitating this group. The total concentration

of the cations to be precipitated is so small that any reaction involving them has no important effect on the hydrogen ion concentration.

Summary

It is strongly recommended that students in qualitative analysis should be required to report the concentration of each cation found to the nearest mg. per ml. and that each liquid unknown supplied to him should have a total cation concentration of one percent (or 10 mg. per ml.).

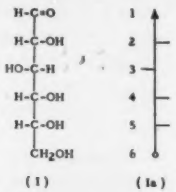
This gives the student a more realistic situation to deal with, makes it possible to grade his report more fairly, and provides for better application of the theory usually taught in conjunction with such a course.

A METHOD FOR RECALLING THE CONFIGURATIONS OF THE ALDOHEXOSES

THEODORE G. KLOSE
Loyola University, Chicago

The use of mnemonics has been called upon to assist in remembering the projection formulas and, consequently, the configurations of the aldohexoses. Two words, *gam* and *gat*, formed from the first letters of the names of the six sugars; galactose, allose, mannose, gulose, altrose and talose aid in reproducing their structures. In order to use this system of memory aid, a student must know the structure of the open chain form of *d*-glucose and the names of the other sugars.

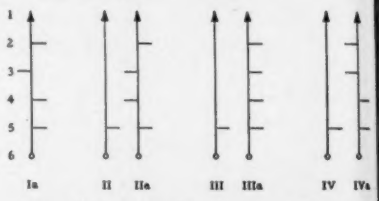
The method of reproducing the structures of the sugars is as follows: The projection formula for *d*-glucose is drawn (I) and from it is obtained a simpler method of representation (Ia) where the vertical line indicates the carbon chain, the arrow the aldehyde group, the circle the hydroxymethylene group and the short, horizontal lines the secondary hydroxyl groups. The *d*- or *l*-configuration of a carbon atom is indicated by placing



the horizontal line to the right or left of the vertical line, respectively.

The configuration at carbon atom five in an aldohexose determines whether a sugar belongs to the *d* or *l*-series, therefore, molecule Ia must be of the *d*-form. Since the sugars under consideration exist in eight *dl* pairs, a knowledge of the projection formulas of the *d*-forms is sufficient. Therefore the horizontal line at carbon atom five will be on the right in all eight forms.

To obtain the three sugars from the word *gam*, the figures II, III and IV are drawn.



By interchanging the substituents of *d*-glucose (Ia) at carbon atoms 4, 3, and 2 in that order and keeping the configuration at carbon 5 constant, the skeletal structures IIa, IIIa and IVa, corresponding to *d*-galactose, *d*-allose and *d*-mannose, are obtained.

Using form II, the skelton form of *d*-glucose and the mnemonic, *gat*, it is easy to reproduce the structures for the next three aldohexoses.

Interchanging the groups at carbon atoms 4 and 3 in *d*-glucose yields *d*-gulose (V); at carbon atoms 3 and 2, *d*-altrose (VI); and at carbons 4 and 2, *d*-talose (VII). (In the two dimensional drawing the transference is represented by mov-

ing the short horizontal lines from one side of the vertical line to the other.)

The structures of *d*-allose and *d*-altrose should not be confused, since the former occurs first in the derivation from *d*-glucose, and is first alphabetically. The same reasoning applies to *d*-galactose and *d*-gulose.

The eight *h*-isomer of the *d*-configuration is *d*-idose (VIIIa), and while it does not fit in the mnemonic words, it is easy to reproduce from *d*-glucose by changing the configurations of carbon atoms 4, 3 and 2 simultaneously.

It is well-known that the *l*-configuration of any sugar can be obtained by drawing the mirror image of the *d*-structure. Therefore, IX, the mirror image of VIII is *l*-idose.

Summary. A new system for recalling the configurations of the sixteen isomeric aldohexoses has been devised as well as a method for drawing their structures.

GEOGRAPHY

OCCUPANCE OF THE MORAINE BORDER OF NORTHERN ILLINOIS

JOHN H. GARLAND
University of Illinois, Urbana

The Terrain

Between the valleys of the Fox on the east and the Rock on the west lies the Moraine Border district of northern Illinois. North of the upper Illinois Valley, which forms the southern limit of the district, the crescentic recessional moraines of Wisconsin glaciation converge and give to the area a pleasing rolling surface which is quite in contrast to the flat terrain of the Grand Prairie south of the Illinois valley. The broad Valparaiso moraine enters the district from the east, the Bloomington moraine dominates the central portion, and the pre-Bloomington till extends westward toward the Rock Valley terminating in the White-Rock moraine (fig. 1).

Physiographically the northeastern portion of the district lies within the Wheaton Morainal country, the southeast is a part of the Kankakee Plain, the northwest is a part of the Rock River Hill country, and the remaining central and southwest is the northern portion of the Bloomington Ridged Plain into which extends an arm of the Green River Lowland.[1]

Prairie, interrupted at intervals by prairie groves, originally dominated the southern and western portions of the area; whereas to the north and east it was covered by an extensive series of hard wood deciduous forests. Like the Grand Prairie the wooded areas occupied the better drained lands, especially those in the drainage basins of the streams. Poorly drained uplands and extensive swails and sloughs on the featureless ground moraine plains created a drainage problem in this district almost as great as that of the Grand Prairie. Drainage ditches and field tile have transformed most of the wet areas into productive farm land leaving only local names of sloughs and prairies as reminders of the early poorly drained countryside.

Although three major streams, the Rock, Fox, and Illinois, form three sides, the district consists of two drainage areas, the Northern and Southern sections (fig. 1). The Northern section is chiefly the irregular drainage basin of the north and south branches of the Kishwaukee, which flows westward into the Rock. The tributaries of the Fox are very short and, with the exceptions of the lake region in the northeast, are of no significance to the Northern section. The Southern section is tributary to the Illinois, the major feature of which is the lower Fox River.

Cultural Patterns

Upon the terrain has been developed a variety of occupance patterns all of which are rural and agrarian. The variety and arrangement of the patterns are such, however, that the

[1] M. M. Leighton, Geo. E. Ekblaw, and Leland Horberg. "Physiographic Divisions of Illinois," *The Journal of Geology*, Vol. 56, No. 1, January, 1948.

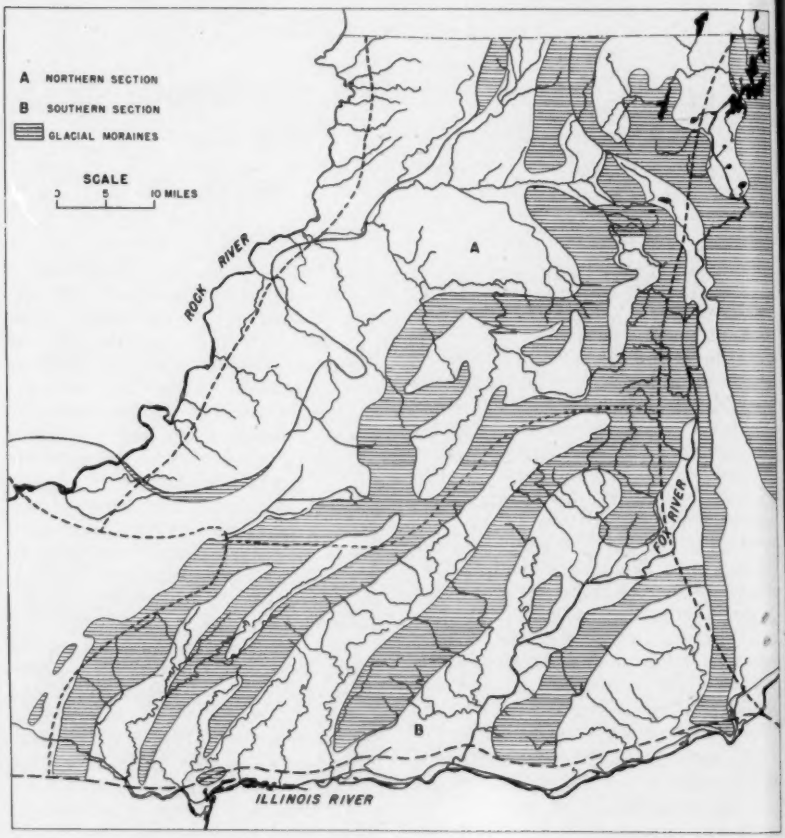


FIG. 1.—Physical patterns of the Moraine Border district.

section is actually a land of transition.

SETTLEMENTS

Although the bordering valleys are zones of urbanization, the Moraine Border district is a land of towns and villages and evenly spread farmsteads. There are only 140 incorporated towns and cities in the entire district which includes parts of 12 counties (fig. 2). Of that number there are only ten large enough to be within the city classification of 2,500. Seven of these are in the Northern section and three in the Southern. Of the ten the two largest are DeKalb and Belvidere. In the Census of 1940 their respective populations were 9,146 and 8,094 although recent estimates place them at 12,150 and 10,051. Four of the ten cities, Belvidere, Woodstock, Sycamore, and Princeton, are county seats. With the exception of DeKalb and Sycamore,

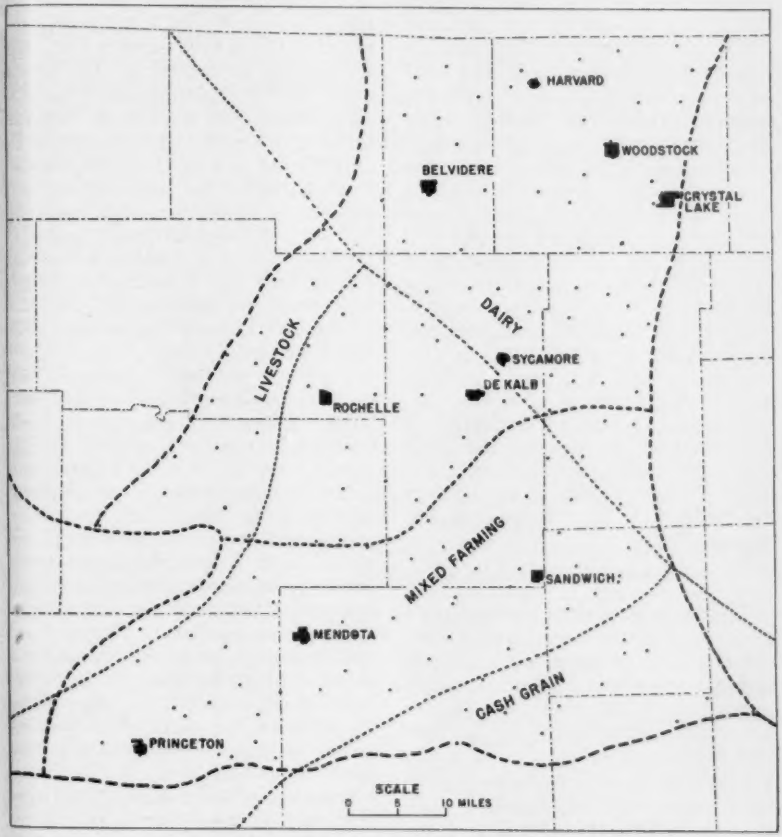


FIG. 2.—Occupance patterns of the Moraine Border district.

which are about seven miles apart, the cities are well spaced indicating a basic agrarian service center function. It is well to note that DeKalb, the largest city, is the most industrial of all. The fact that the county court house is in Sycamore and the Northern Illinois State College is in DeKalb, a short distance away, indicates some of the rivalry arising from urban spacing.

The towns and villages are aligned at five to eight mile intervals in a general east-west orientation. This obviously is due to the railroad net which in general extends across the district as a series of lines radiating from the Chicago metropolitan district. Pre-railroad settlements reached by the railroads grew, whereas the rest disappeared with time as the post-railroad pattern of settlements crystallized. Only two railroads extend across the district in a north-south trend and they are small freight lines.

The original county and township survey gave to the district the traditional checkerboard of section-line roads. Right of travel altered some of them, and the lack of surfacing material obliterated many more. With the development of the automobile, the truck, and the bus, national and state hard-surfaced highways were projected through the district, both from east to west and south to north. Although local interests were desirous of perpetuating the pattern by routing the concrete highways through the small villages, the undesirability of routing fast traffic through villages has been demonstrated both as far as the traffic and the individual settlement is concerned. Thus patterns are being developed to by-pass villages by a short enough distance that neither the traffic nor the village is inconvenienced.

Agricultural Patterns

Although dominantly rural and agrarian, the Moraine Border district is a land of transition as far as farming types are concerned. Three critical farming type boundaries cross the district dividing it into four distinct areas.[2]

The first farm type boundary is the western limit of the dairy belt which divides the district from northwest to southeast. Within the northeastern part of the dairy landscape is outstanding. Modern dairy barns and silos, herds of Holstein cows, well-fenced pastures, and fields of fodder are the agrarian occupance features of the rolling morainal land. Dairy farms are large, well-painted, well-kept and imposing in appearance, and most exacting in requirements.

The towns and villages are collecting centers, in some of them are dairy plants belonging to organizations located in the Chicago metropolitan district toward which the fresh milk moves daily. Collectors truck the raw milk in cans from the dairy farms to collecting stations from which glass-lined tank trucks and trains continue it citywards. The railroad is no longer as important as it once was when each of the several railroads radiating out through the milk producing region ran at least one slow express daily, known as the milk train, for the purpose of transporting milk to the metropolitan district.

Distance, no doubt, is an important factor in crystallizing this particular pattern of occupance. Natural environmental conditions, although advantageous within the dairy farming zone, do not change markedly at the dairy boundary which has remained constant for years. It is well to note that dairy farming, although the finest type of agrarian adjustment, is highly specialized, the equipment is enormous and expensive, and a fine dairy herd capable of demanding highest returns is not easy to build up. Thus the area has crystallized as a dominant occupance feature of the Moraine Border district.

Near the western edge of the district, approximately at the boundary of the Wisconsin drift, is the boundary of mixed livestock farming. Beef cattle, hog, and dairy farm, especially those selling to creameries, dominate the area. Although the crops in the fields are essentially the same over the entire Moraine Border district consisting of corn, small grain, hay and pasture, the commercial aspects are quite different. Distance from the Chicago metropolitan district is the significant factor. Loading chutes along the railroad in the villages and livestock trucks on the highway take the place of the daily milk truck.

[2] H. C. M. Case and K. H. Meyer, Types of Farming in Illinois. Univ. of Ill. Agr. Exp. Sta., Bull. 403, June 1934.

The infrequence with which stock beef cattle, fat hogs, or even cans of cream are marketed is a vital factor. On the other hand the rolling terrain is a significant pasture land.

The southeastern part of the district, especially the area between the Fox and Illinois rivers is a land of cash grain farming similar to the Grand Prairie south of the Illinois Valley. The deep black soil of the Kankakee plain is utilized as only the richest of soil can be for commercial grain farming. There the grain elevators are large, the barns are small, and grain is trucked to market.

Between the livestock farming on the northwest and the cash grain farming on the southeast is a broad transition zone of both livestock and grain farming extending southwestward from the dairy boundary. In the same manner trend the recessional moraines of Wisconsin glaciation, the Bloomington, Cropsey, and Farm Ridge moraines, separated by extensive elongated areas of poorly drained ground moraine. Thus, beyond the limits of profitable dairy marketing, the morainal ridges and interspersed plains are the sites of both livestock and cash grain farming.

Here both stock loading pens and grain elevators line the railroads in the little agricultural villages and livestock trucks traverse the highways. Although this portion of the Moraine Border district is too far from the Chicago metropolitan district for the daily shipment of fresh milk, it is the nearest area to the world's largest stock yards for the periodic delivery of live hogs, sheep, and cattle. The extent to which portions of the district have been used to fatten cattle and western sheep is notable. The large sheep feeding yards are no longer as important as they once were and some have disappeared entirely. It was within this portion of the district that a part of the government-sponsored wartime hemp growing was centered.

Industrial Patterns

In an agrarian structure such as that of the Moraine Border district, industry is of little significance. Here the major features are in keeping with the agricultural background which the towns and villages serve. Canning factories account for the most widespread manufacturing activity of the district. Corn, peas, lima beans, tomatoes, pumpkins, and asparagus are among the vegetables packed by the canning companies which are most important in the Northern section especially in the larger towns. Belvidere, Marengo, Sycamore, and Rochelle are the significant canning factory towns. Although the canning activities are limited to the summer season, causing a marked labor problem, vegetable growing is carried on chiefly on farms owned outright or leased for terms of years by the canning companies.

Among the industries of the district designed to use or to prepare perishable agricultural produce for market are the dairies and creameries in the towns and villages, especially in the dairy farming portion of the district. Similarly the hemp mills of the war period were constructed to process hemp fibers. Government mills were constructed near Earlville, Shabbona, and Kirkland.[3] Since the close of the war, these factories have been closed, offered for sale, and at least one has been converted to other industrial purposes.

At an early date small shops and factories making farm machinery

[3] John H. Garland, "Hemp—A Minor American Fiber Crop," *Economic Geography*, Vol. 22, No. 2, April, 1946.

and other equipment for the agricultural countryside were widespread. Today most of these have disappeared as farm machinery manufacturing has become standardized and centralized in a few large companies. A few agricultural service manufacturers as well as those depending on a general market have developed in the large towns and cities. Notable among these are the manufacture of milking machines and dairy farm equipment at Harvard and Deisel engines at Rochelle, whereas machine shops that make parts for farm machinery are widespread. The invention of barbed wire at DeKalb and the development and operation of the American Steel and Wire Company there for a number of years gave to the largest city of the district the most industrial atmosphere. In a like manner the manufacture of sewing machines is outstanding in Belvidere, the second largest city. DeKalb was selected during the war for the site of an airplane factory.

Many other items such as telephone parts, electrical switches, cardboard boxes, dry cleaning machinery, furniture, barber's tools, yarn, typewriters, and the like are made in small factories in many of the towns and cities. The manufacture of nationally advertised pianos at DeKalb is one of the industries in which central position within the national market is significant.

Although there are shreds of evidence that light industries are interested in and are actually moving towards the towns and villages of the countryside which lies between the Rock River, Fox and Illinois valley industrial districts, the dominant note of the Moraine Border district is one of agricultural transition which occupies a rolling terrain of variable glacial features.

GEOLOGY

COAL RESOURCES OF FRANKLIN COUNTY, ILLINOIS*

GILBERT H. CADY
State Geological Survey, Urbana

Franklin County, Illinois, is unique as a coal producing area in several ways: It is the only coal producing county in the State which at the start of the century had produced no coal and contained no coal mines. In 1946, however, this county produced more coal than any other county in the State—14,470,904 tons or 23 percent of the total State production for that year. Its average production per mine in 1946 of 1,113,146 tons was exceeded only by Christian County where five mines produced an average of 1,279,882 tons. One mine in Franklin County attained the highest output in the State of 2,469,470 tons, a relative position which this mine has held for 8 years and for 20 out of 22 years prior to 1947. This same mine also holds the daily output record of the State of about 15,000 tons, a record, however, which was nearly equalled by a rival mine in the county. It had the fame, at one time at least, of being the world's largest underground coal mine. Production in Franklin County is at present in the hands of five operating companies, one mine being a captive mine owned by a railroad which takes all its production.

Franklin County originally contained what appears to have been the State's largest volume of coal with a sulphur content of less than 1.25. A considerable part of this coal contained less than 1 percent sulphur. It also contains the State's thickest known bed of coal, which is 9 to 14 feet thick over considerable areas. Franklin County has probably been more thoroughly explored by the diamond drill than any other county in the State, but exploration has not often extended below No. 5 coal bed, only thirteen holes having been drilled to the greater depth, out of more than 300 that have been drilled.

The coal mined in Franklin County is produced by fewer men per ton—8.7 tons per man day in 1946—than that produced by any other county in the State except Christian which had a rating of 11.5 tons per man day for the same year. The 1946 record in neighboring Saline County, in spite of the considerable strip-mine tonnage, was 6.5 tons per man day, and for Macoupin County 7.6 tons. Fulton County, on the other hand, where most of the coal comes from strip mines produced coal in 1946 at the rate of 21.22 tons per man day.

Many more persons are employed in the coal industry in Franklin County mines than in any other county of the State, 7,402 employees being reported for 1946. The county with the next largest mine pay roll is Macoupin with 2,693 employees.

Railroads conveying coal out of Franklin County derive an annual revenue of about 20 million dollars from this service, assuming an average freight payment of $2.00 per ton. In 1946 about 10 million tons of coal were shipped on four railroads serving the county, requiring

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200,000 fifty-ton cars, or 4,000 fifty-car trains, or an average of more than 10 such train-loads daily during 1946.

The fatality record of the mines in Franklin County has fallen from the high rate of 4.89 fatalities per million tons of coal produced between 1911 and 1919 to an average of 1.11 fatalities per million tons between 1940 and 1946. This decline, although still higher than the State average of 0.4 in 1946, which is unusually low, has been brought about in spite of a highly hazardous, natural gassy condition in these mines, largely owing to the contributions to mine safety made by one of the foremost mine safety engineers in the country and a notable citizen of the county, John E. Jones. The present methods of mine rock dusting in widespread use throughout the country are largely due to Mr. Jones' ingenuity and persistence.

Over against the numerous facts pointing to the great importance of the coal mining industry and the coal resources to this region are other facts that call for the evaluation of the permanence of this industry and the availability of the coal resources. To what extent are these resources actual reserves of wealth and prosperity?

The area of the county is relatively small. This is the 66th county in respect to size, having an area of 445 square miles (284,716 acres). Furthermore, in about 14 percent of the area or 60½ square miles (38,685 acres) the No. 6 coal bed is regarded as unworkable because the bed splits into unmineable thin parts. This leaves 384½ square miles (246,031 acres) of the county underlain by workable No. 6 coal bed, assuming that a bed less than 6 feet in thickness at depths varying from about 750 to 850 feet is workable.

There is the further consideration that vigorous mining has been underway in this county about 45 years with a total output to the end of 1946 of 399,794,122 tons.

The original supply of coal in the No. 6 coal bed has been estimated on

TABLE 1.—ORIGINAL COAL RESOURCES IN NO. 6 COAL BED IN FRANKLIN COUNTY

	Area in acres	Percent of county	Percent of productive area	Estimate 1916 Coop. Bull 15	Estimate 1934	Estimate 1948	Percent
				Millions of tons			
Split coal area	38,685	14	.....	.....	.....	.....	.....
Coal more than 8 ft. thick (Av. 9 ft. assumed)	113,970	40	47	.....	.....	1,814	54
Coal 6-8 ft. thick (Av. 7 ft. assumed)	92,162	32	37	.....	.....	1,142	34
Coal under 6 ft. (Av. 6 ft. assumed)	39,962	14	16	.....	.....	424	12
Total	284,716	.....	.....	3,718	3,282	3,381	.....

various bases from time to time (table 1) and appears to be about 3 1/3 billion tons, of which 424 million tons or 12 percent is probably less than 6 feet thick, 1,142 million tons or 34 percent is between 6 and 8 feet thick, and 1,814 million tons or 54 percent was more than 8 feet thick.

A total of 30 percent of the area underlain by No. 6 coal bed in the county, exclusive of the split-coal area (table 2) (73,454 acres or 114.8 square miles) has been mined out or rendered unmineable (fig. 1) and this area contains essentially all the coal with less than 1 percent sulphur content and much of that with less than 1.25 percent sulphur.

Most of the remaining supply of No. 6 coal bed lies in the eastern half of the county, and only two of the existing mines are probably so situated that they can mine the coal in this area within reasonable limits of cost. It is also significant that several mining ventures in the northeast part of the county north of or along the Illinois Central Railroad from Benton southeastward, found it impossible to maintain production in competition with the more favorable conditions in the mines in the western part of the county.

In spite of the evident realization on the part of the coal mining industry of the approaching depletion of the better and thicker portions of No. 6 coal bed in the western side of the county, no new mining ventures, as indicated by advanced drilling, seem to be underway in the northeastern part of the county.

In this connection attention may well be called to what appears to be an area of relatively thick coal north of Logan and in the vicinity of Bessie in an area traversed almost down the center by a branch of the Illinois Central Railroad running from the vicinity of Akin to West Frankfort (fig. 1). The position of the area is also indicated on Fig. 2 as an area where the thickness of the interval between the No. 6 coal and the first limestone is more than 10 feet. Additional drilling is necessary to prove the area but it seems to hold promise of being the only tract north of the Illinois Central Railroad branch to Eldorado in eastern Franklin Coun-

TABLE 2.—DATA ON DEPLETION OF NO. 6 COAL BED IN FRANKLIN COUNTY

	Acres	Sq. Miles
Total mineable area	246,013	384.4
(Excluding split coal: 14% of county)		
Mined out area:		
A. Actual (25%)	61,649	96.3
B. Including barriers (30%)	73,454	114.8
Total production in tons (to date of mine maps)	385,401,214 tons	
Production in tons per acre:		
A. Actual mined-out area	6,252 tons	
B. Including barriers	5,247 tons	
Thickness of coal removed (in feet):		
A. Actual mined-out area	3.53 feet	
B. Including barriers	2.96 feet	
Percentage of coal removed:		
A. Actual mined-out area		
1. 9 ft. assumed average thickness	39 percent	
2. 8½ ft. assumed average thickness	42 percent	
B. Including barriers		
1. 9 ft. assumed average thickness	33 percent	
2. 8½ ft. assumed average thickness	35 percent	

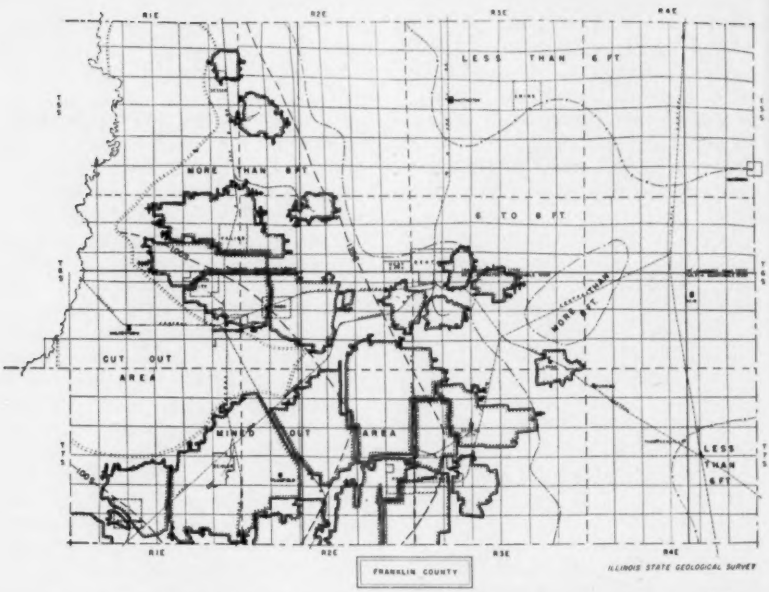

FIG. 1.—Map of Franklin County showing mined-out areas, "cut-out" area, areas in which sulphur content of No. 6 coal bed is less than 1.0 percent, between 1.0 and 1.25 percent, and greater than 1.25 percent; and areas in which No. 6 coal bed is less than 6 feet, between 6 and 8 feet, and more than 8 feet thick.

ty where there are attractive possibilities from the viewpoint of present mining requirements.

In connection with the depletion of resources in No. 6 coal bed in western Franklin County the character of recovery is of interest. The prevailing idea concerning the recovery as expressed by most engineers in the area is that this amounts to about 7,000 tons per acre. Assuming a weight for the coal of 1770 tons per acre foot (a figure long used by the State Geological Survey in coal resource studies) the recovery is equivalent to a bed almost exactly 4 feet thick (7080 tons). This recovery has been in an area where the thickness of the No. 6 bed exceeds eight feet and not infrequently is 10 feet. It seems, therefore, even on the basis of the commonly accepted figure of 7,000 tons per acre that the recovery is less than 50 percent.

Planimeter measurements of the mined-out area indicated on a small scale map (fig. 1) show that the total production of 385,401,214 tons (up to the date of the mine maps) had been taken from a mined-out area of 61,650 acres. This represents an average recovery of about 6,250 tons per acre (table 2), rather than 7,000 tons.

Recovery is not uniform in different parts of the county. Consider the three separate, more or less individually continuous areas, one in the south part of the county, one in the north part (but not including the detached mines near Sesser), and one in the eastern part (but not including the mine at Logan). The recovery (table 3) in the mined-

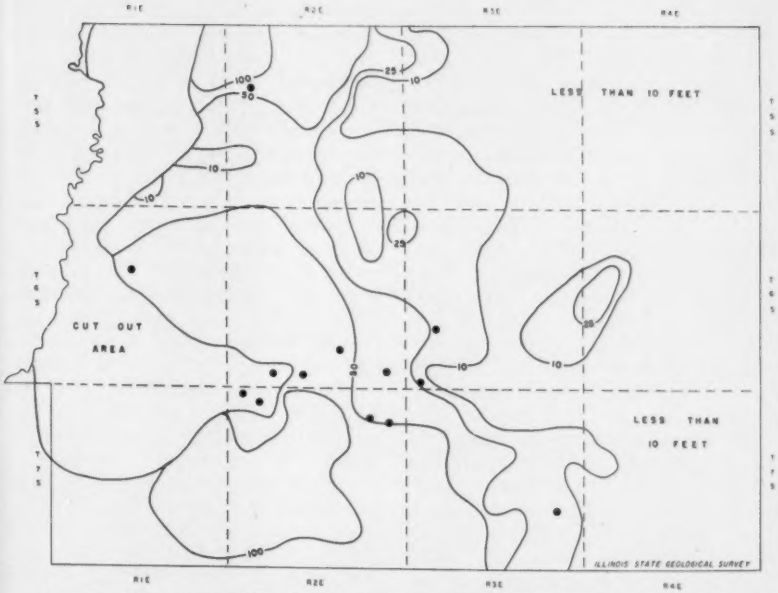

FIG. 2.—Map of Franklin County showing the distribution of variations in the interval between No. 6 coal bed and the first limestone above this coal bed, (10, 25, 50, and 100 feet) and the location of diamond-drill holes extending below No. 5 coal bed.

TABLE 3.—STUDY OF DEPLETION IN THREE SELECTED MINED-OUT AREAS IN FRANKLIN COUNTY

	Area in acres	Total production in thousands of tons	Production in tons per acre	Coal removed (feet)
North Tract				
Actual mined-out area	13,356	85,745	6,420	3.63
Including barriers	16,300	85,745	5,267	2.98
South Tract				
Actual mined-out area	41,228	265,577	6,442	3.64
Including barriers	48,000	265,577	5,533	3.12
East Tract				
Actual mined-out area	3,411	17,275	5,064	2.86
Including barriers	5,500	17,275	3,141	1.77

out southern part is at the rate of 3.64 feet, in the northern tract essentially the same, but in the eastern area is only 2.86. These figures refer only to the actual mined-out area as bounded by the extreme face. If the total area is considered, barrier pillars, town site reserves, railroad right-of-way pillars and unmined irregularities such as those along the margin of the split coal area, the figures are smaller, being 3.12 feet for the southern area, 2.98 for the northern area, and 1.77 feet for the eastern area where abandonment of the mines will undoubtedly result in high barrier-pillar loss marginal to any new operations.

The character and thickness of the No. 6 coal bed bears a definite although not fully understood relationship to the black shale and limestone caprock. Wherever the coal bed is separated from the black shale by less than about 10 feet of strata (usually by gray shale) the coal bed is rarely more than about 8 feet thick and commonly not more than 6 feet thick. The thin coal bed is characterized by a high sulphur content, usually more than 2 percent. The critical relationship, however, is not that of thickness of bed but one apparently involving the proximity of the black shale. Because of this very definite and well substantiated relationship it seems probable that the thin No. 6 coal bed in the eastern and northeastern part of the county, where the black shale and limestone lie close above the coal bed, will have a relatively high sulphur content from which it will probably be difficult but perhaps not impossible to produce the same high quality fuel as has been shipped out of Franklin County for many years.

There is at least one other matter that affects the volume of coal reserves to some extent. It is regarded as good practice to guard oil test holes by at least a 100-foot pillar, that is by a pillar not less than 200 feet in diameter. Where pools have developed in a mining area the mines and position of the drill holes are usually so planned as to reduce to a minimum the extra loss involved in an oversize pillar for an oil well or test hole. Where wells are drilled in abandoned mines or abandoned parts of mines no extra loss of coal is involved unless the well or wells get out of hand in the mine and cause disruption of mining and loss of coal or even of the mine. In the case of wildcat wells or drill-holes or where pools consist of only a few wells some loss of coal may be expected, particularly if uncertainty exists in regard to the character of the plugging. In such a case it is advisable to provide a 200-foot rather than a 100-foot pillar around the drill-hole. A 100-foot pillar contains about 1277 tons per foot of coal or about 10,000 tons for an 8-foot bed. A 200-foot pillar would contain about three times as much. There are, up to date, in the order of 75 to 100 oil test holes in the largely undeveloped eastern half of the county (fig. 3).

Brief consideration may now be given to the resources present in Franklin County in beds other than No. 6. Of these coal No. 5 (fig. 4) which lies from 30 to about 100 feet below coal No. 6 is the most important and most widespread. Its continuity is probably somewhat greater than that of No. 6 since it appears to be present under at least part of the "split-coal" area although to what extent is not well known. In general No. 5 bed is 3 to 4 feet thick, and fairly uniform in thickness. In the north part of the county there is one area where the bed is 5 feet thick, being nearly as thick as the No. 6 bed. The number of drill-holes that have penetrated to No. 5 bed is too small and the holes are too

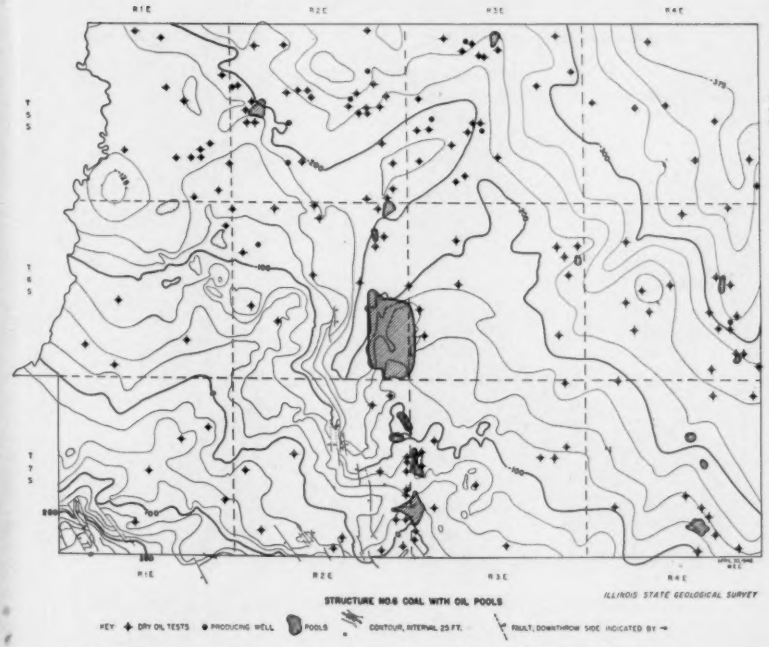

FIG. 3.—Structure of the top of No. 6 coal bed, location of oil pools, and of oil-test holes not in pools (wildcat holes).

erratically distributed to justify statements as definite in regard to the quantity of coal present in this bed as can be made in regard to No. 6 coal bed. There is particular need for more information in the northeast part of the county and in the "split-coal" area.

As a coal reserve, in the sense of a body of recoverable coal under prevailing mining conditions, the No. 5 bed has uncertain and rather doubtful value. It is very doubtful whether it can be recovered where it lies below areas of mined out No. 6 bed, particularly where the interval is less than about 50 feet. Unless mining conditions change considerably, and this possibility of course exists, the value of No. 5 coal bed as a real reserve rates low. However, in those parts of the county where the No. 6 and No. 5 bed lie 75 to 100 feet apart mining methods may be devised, as new machines become available, so that both beds can be recovered simultaneously. It seems reasonable to regard as possible the recovery of as high a proportion of the combined 10 feet of coal in the two beds as has been recovered from the single bed of the same thickness in western Franklin County. There are possibilities of improved recovery in the retreating method of mining that have not been explored but deserve trial. In any case, however, the No. 5 coal bed will probably not supply the natural premium quality of coal character-

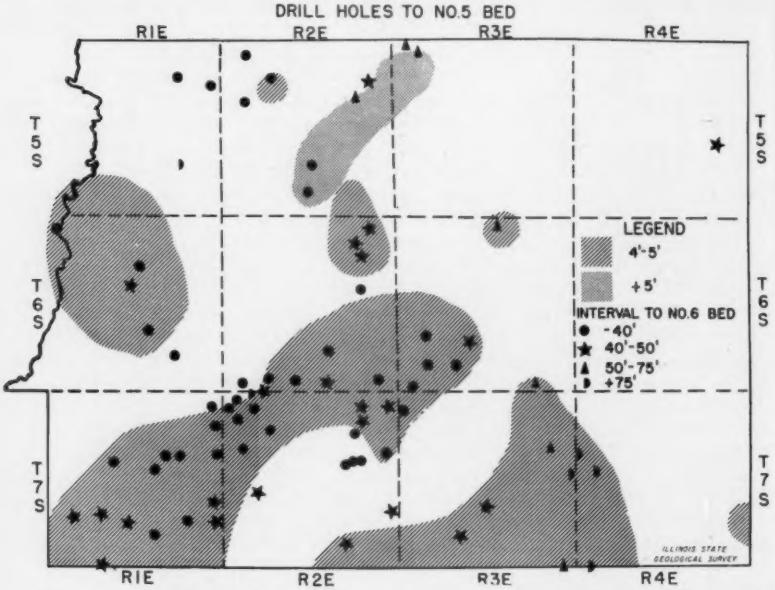

FIG. 4.—Map showing drill-holes that have penetrated No. 5 bed, distribution of variation in the thickness of the No. 5 bed, and the distribution of interval between No. 5 and No. 6 beds.

istic of the No. 6 bed where it is now being mined.

The amount of coal represented by the No. 5 coal bed in Franklin County, assuming that there are 309 square miles in which the bed averages 3½ feet thick (3 to 4 feet), 125 square miles in which it averages 4½ feet (4 to 5 feet) and 11 square miles in which it averages 5 feet (5 feet plus) is as follows:

Thickness Feet	Square Miles	Tons
3½	309	1,225,123,200
4½	125	642,297,600
5	11	63,304,000
Total		1,929,724,800

or roughly 2 billion tons. Of this 704,601,600 tons represent the coal bed where it is more than 4 feet thick. Of this area 60 square miles, in which there are 310,953,000 tons of coal, is in the area where No. 6 bed has already been mined out and the possibility of recovery of No. 5 coal is regarded by the writer as doubtful. This leaves about 400 million tons of coal thicker than 4 feet in the area where No. 6 coal has not yet been removed. Of this probably no more than about 200 million tons is recoverable, unless mining methods change considerably, which is possible.

In view of the very little information in regard to the thickness of No. 5 coal bed in the northeastern part of the county these estimates are based on an assumed thickness of 3½ feet. This estimate involves the resources in this bed for about one-quarter of the area of the county. It may be hoped that fur-

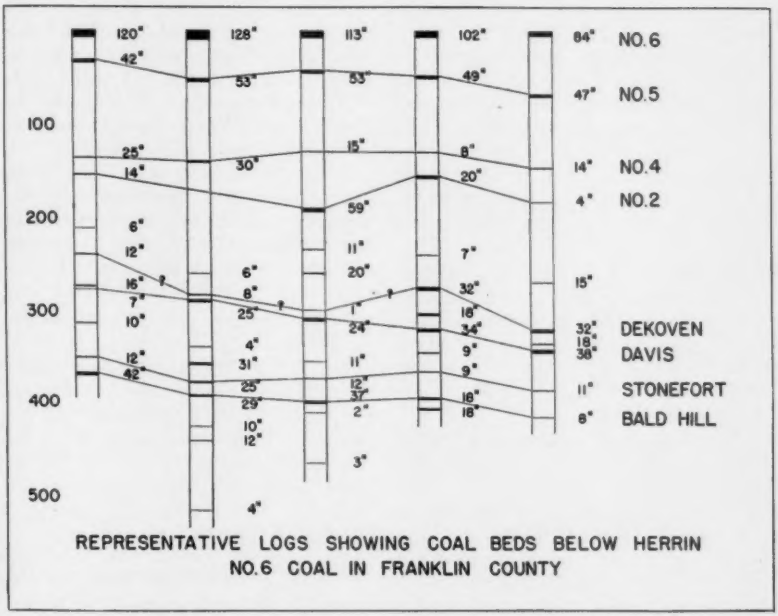

FIG. 5.—Coal beds penetrated in five selected diamond-drill holes at scattered positions in Franklin County.

ther drilling may find that this estimate is too conservative.

The coal resources of the county are not completely represented by the No. 5 and No. 6 coal beds. There are no beds exceeding about 18 inches in thickness above the No. 6 bed. The Cutler coal bed, commonly present 30 to 40 feet above the Herrin (caprock) limestone may occasionally reach 2 feet, but it is lenticular and generally unmineable. The accompanying chart (fig. 5) shows the position and thicknesses of coal beds below No. 6 bed in a group of diamond-drill holes that have been rather recently drilled here and there in the county. The amount of such deep drilling has been relatively small (fig. 2) and not scattered widely enough to provide a very satisfactory picture of the areal extent of the deep lying beds. The general conclusion that can be derived from the available information is that although occasionally coal beds 4 to 5 feet thick may be present and be penetrated in drilling, the beds are usually not thick and are characteristically lenticular and discontinuous. The two beds believed to have the widest distribution are known as the DeKoven and Davis lying between 250 and 300 feet below No. 6 bed. Even these are thin and become difficult to recognize toward the west, and even on the east side of the county are not likely to be more than 40 inches thick. The DeKoven, the upper bed of the two, is likely to be "cut out" by the overlying Palzo sandstone. The well known Murphysboro coal bed of Jackson County has not been recog-

nized with certainty among the coal beds penetrated in Franklin County. It may be either the Stonefort or Bald Hill bed. It is not the DeKoven and Davis bed as was once thought.

It is not probable that these lower coal beds will ever provide a basis for large coal mining industry such as that with which we are now familiar in Franklin County, although it cannot be said that none of these beds will ever be mined. Further drilling may discover considerable areas where one or more of these beds maintains a thickness of 4 to 5 feet. Furthermore, "ever" is a long time and man may get very desperate for fuel.

Underground gasification holds some possibility for utilizing the energy present in the thinner coal beds and in portions of the thicker beds where the quality is poor, such as in the split portions of the No. 6 coal bed. Once the No. 6 bed is entirely worked out adjacent to the "split-coal" area the development of gasification projects as a means of recovering the energy available in the split portions of the bed is a possibility that should not be overlooked. The same procedure might be applied to No. 5 and lower beds where conditions might be suitable. It is very desirable that underground gasification be tried under conditions existing in the coal fields of the middle west in order to provide a satisfactory basis for determining its applicability to these coal beds.

Conclusion

The coal resources of Franklin County may be classified into four categories: First, those resources which represent coal which can be and probably will be recovered under present conditions of mining practice and competition, the certain reserves; second, those resources represented by coal 6 to 8 feet thick which probably will be recovered, the probable reserves; third, those resources represented by a coal bed less than 6 feet thick concerning which the possibilities are doubtful, the doubtful reserves; and, finally, those resources represented by beds too thin or irregular, or both, that probably never will be worked and therefore cannot be regarded as reserves of energy or wealth.

The definite or certain reserves are represented by the approximately 897 million tons of coal in a bed 8 feet or more thick. The coal in this reserve is held very largely by two companies with a present combined output of about 10 million tons. By maintaining an unusually high rate of recovery of about 55 percent at the same annual rate of production this body of coal should last another fifty years. It is not to be expected, however, that the man power required to mine this volume of coal will continue at the present rate but that it will decrease. Accordingly the mine pay-roll in the county will undoubtedly fall from year to year partly because of the complete depletion of some of the mines and as a result of more efficient recovery in terms of tons per man day. A stepping up of the production by these two mining companies would of course tend to maintain pay-roll volume, but would shorten the life of the field.

The second category of reserves is represented by No. 6 bed where it is between 6 and 8 feet thick and by No. 5 bed where it is more than 4 feet thick. Consider No. 6 coal bed first: The probability of mining in this area containing approximately a billion and one-quarter tons of coal is affected by the absence of operating mines and the

more important unprofitable experience of companies that have undertaken such mining in the past. In general this intermediate area of the No. 6 coal bed is intermediate in other ways than in geographical position. The coal is characterized by considerable variability in quality and thickness, the sulphur content varying in short distances from relatively low to relatively high. The roof conditions provide a hazard that mining companies will hesitate to face. The interval between the coal bed and the caprock varies irregularly with lenticular bodies of gray shale commonly intervening between the coal bed and the black shale that usually lies immediately below the caprock. Cost of development will be increased by the need for more than the usual number of holes in order that irregularities may be sufficiently explored. Successful operation of this 6 to 8-foot coal bed also calls for more technical study of the roof material than has yet been applied to such rock, but considerable and possibly the best information about conditions in the area will be obtained as the mines operating in the more favored reserve area approach the margin of that area and encounter thinner coal and more irregular roof conditions. For the present at least it appears that the area of 6 to 8-foot coal should be written off as an immediate reserve, but the general thickness of the coal is such that a few improvements in mining or cleaning practice, or both, might very well throw it into the category of the immediate reserve.

With respect to No. 5 coal bed: The coal present in this bed lies in either the probable or doubtful reserves. The portion of the bed concerning which there is undoubtedly the most interest is where the bed underlies the already worked out areas of No. 6 bed because it can be reached so easily from shafts now working in the upper bed. Some of these shafts actually extend to the No. 5 bed already. It would seem as though the No. 5 bed could be worked as cheaply while operations are still active in No. 6 as after such operations cease, and failure to start such operations up to the present is not an encouraging indication of the workability of the bed.

The area of greatest promise with respect to No. 5 bed appears to be the approximately 11 square miles in the northern part of the county where the bed is more than 5 feet thick. It would seem desirable if the coal should be explored in this tract to mine both No. 6 and No. 5 beds from the same shaft. The two beds are sufficiently widely spaced and the lower coal sufficiently thick so that it might be possible to work the lower and upper beds contemporaneously in a large area in the southeastern part of the county where No. 6 coal is over 6 feet thick.

In the northeast part of the county where No. 6 coal is less than 6 feet thick both beds are 800 feet or more in depth and the coal resources in both beds rate no better than doubtful reserves although there has not been enough drilling for definite estimates.

The coal present in the beds below No. 5 coal represents a doubtful reserve. Drilling to date does not provide information sufficient to justify including such coal beds that have been encountered in either of the high categories. In certain areas there seem to be lenticular fairly thick bodies of one or more of the coal beds below coal No. 5 but no two holes seem to have penetrated coal beds as much as four feet thick at the same stratigraphic position except possibly in

the case of the Davis coal. This bed seems to be that thick only in the southeastern part of the county. It is possible that some time one or more of these beds might be found suitable for underground gasification, but it is not probable that they will be mined by shafts, except possibly in very local areas.

The present study of the status of coal resources and coal reserves in Franklin County points to the complete exhaustion of the high quality more easily mined No. 6 coal within the county in a matter of about 50 years or less. This depletion of No. 6 coal where it is more than 8 feet thick will undoubtedly be accompanied by the gradual decrease in the number of individuals supported by the mining industry in the county. It is quite possible that this decrease may take place slowly enough to cause no particular hardship. Furthermore, there is a possibility that some of the slack, should any exist, may be taken up by the start of new operations in the coal lands underlain by No. 6 bed where it is between 6 and 8 feet thick. This possibility depends a good deal upon progress made in mining methods, in improved efficiency of mining machines, in the improved understanding of the behavior of roof materials, and on improvements in mechanical devices for converting the energy in the coal into mechanical energy. Encouragement must be given to coal research in fields, such as geology, chemistry, and various branches of engineering impinging upon the coal mining industry and various aspects of coal utilization, including underground gasification.

SUMMARY OF RESOURCE DATA FOR NO. 6 COAL BED IN FRANKLIN COUNTY

	Acres	Percent	Square miles
The area of the county	284,716	.....	445
The "split-coal" area	38,685	14	60.5
Area exclusive of "split-coal" area	246,031	86	384.5
Area in which No. 6 coal bed has been mined or rendered unmineable	73,454	26	114.8
Total area No. 6 coal bed unavailable either mined out or in "split-coal" area	112,139	40	175.2
The available balance	172,577	60	269.8
Of the available balance area (100%)			
No. 6 coal is less than 6 feet thick in	39,962	23	62.4
No. 6 coal is 6-8 feet thick, excluding mined out area, in	90,396	52	141.2
The remaining area No. 6 more than 8 ft	42,219	25	66.0

Converted into tonnages these data signify that

The area of No. 6 less than 6 feet thick contains	424,396,000 tons
The area of No. 6 between 6 and 8 feet thick contains	1,125,887,000 tons
The area of No. 6 in which No. 6 coal is more than 8 feet thick, contains	896,917,000 tons

NO. 5 COAL BED

The coal in No. 5 coal bed in Franklin County is approximately 2,000,000,000 tons. It ranges from a possible to a doubtful reserve.

OIL ACCUMULATION IN THE CYPRESS SANDSTONE IN THE HERALD POOL, WHITE AND GALLATIN COUNTIES, ILLINOIS*

NANCY McDURMITT
State Geological Survey, Urbana

Introduction

The Herald pool is located in White and Gallatin counties in southern Illinois (fig. 1). The pool covers an area of approximately 1600 acres. Since its discovery in 1940, a total of 130 producing wells have been completed, of which 65[1] have produced oil from the Cypress sandstone. This sandstone has been chosen for study, and the discussion following is confined to it.

The Cypress is one of the lower formations of the Chester series. In the Herald pool area it consists of three sandstones, commonly with interbedded shales. The two lower sandstones are thick and fairly consistent, and sometimes separated by thin shale. It is the upper sandy zone which is productive in the Herald pool. It is an extremely variable zone of shale, sandy shale, and sandstone. The sandstone ranges from a tightly cemented sandstone to a clean permeable quartz sandstone, which is the pay zone. Normally the sandstone is overlain by shale or shaly sandstone. Occasionally the whole upper zone becomes a shale or shaly sandstone. In places there is no shale above the sandstone, so that it is directly overlain by the Barlow limestone. However, in most cases, it is the shaly layer over the pay zone which forms the caprock.

Structure

The Herald pool is in the southern part of the Illinois basin. The structure of the pool consists of three "highs," with a general north-south trend. Figure 1 shows structure contours on the base of the Barlow limestone, that is the top of the Cypress formation. In general the Cypress production is controlled by these features. The northernmost anticline is the largest of the three and has on it the largest number of wells.

Figure 2, (sec. 3, T. 7 S., R. 9 E.) shows oil accumulation in a simple structural trap. The wells high on the structure produce oil and water; those low on the structure are dry holes, often producing water with possible shows of oil. The closure of the pay is about 6 feet.

The strata in the southern part of the pool are cut by a fault or fault zone, which strikes north and northeast and dips eastward about 50° to 65°. The fault there cuts a structural high on the Cypress. On the upthrown side—the west side—the pay dips westward from the fault (fig. 3, secs. 22, 23, T. 7 S., R. 9 E.). Several wells produce oil near the fault. It is probable that the trap is sealed by an impervious bed on the opposite face of the fault which is in contact with the pay.

Depositional Variations

Although the Cypress production in the pool is generally controlled

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[1] Secs. 27, 33, 34, 35,—6S-9E; Secs. 2, 3, 4, 10, 11, 14, 15, 22, 23,—7S-9E.
Includes three wells producing from other formations also.

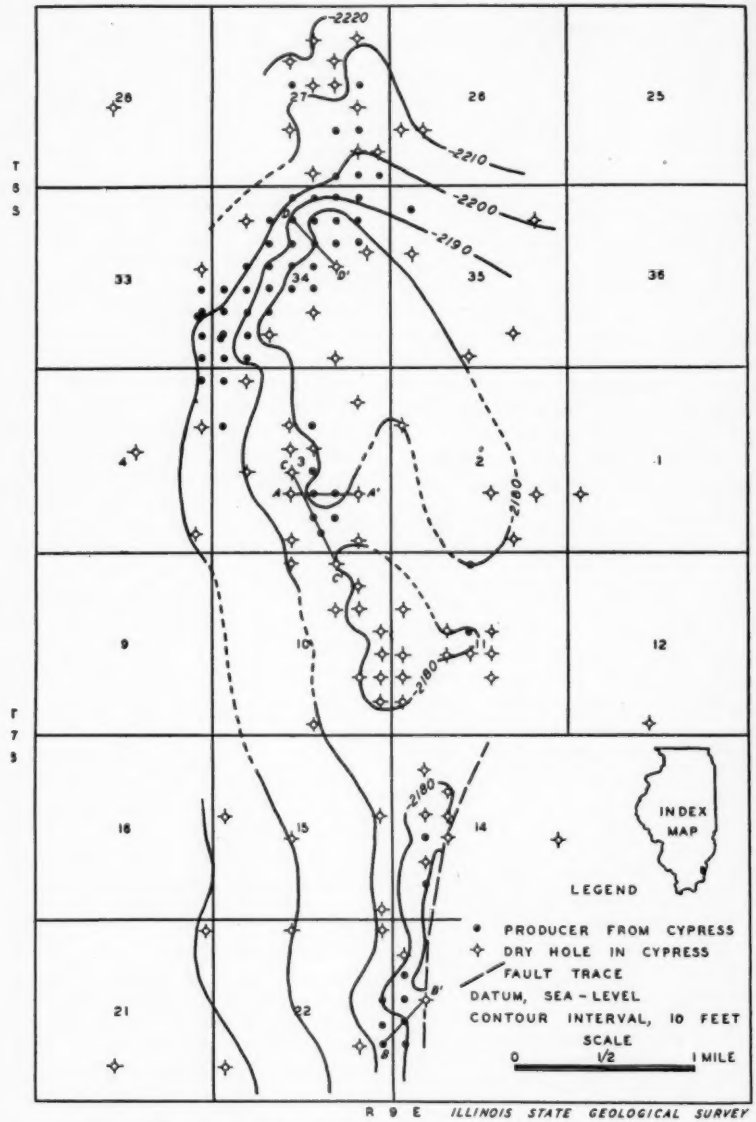

FIG. 1.—Structure map of the Herald pool. Locations of cross-sections are shown by straight lines. Index map of Illinois shows location of the pool.

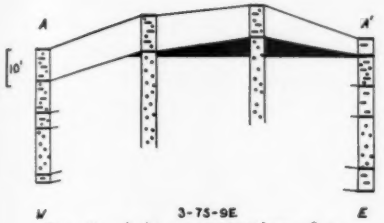

FIG. 2.—A-A′, cross-section of a structural trap.

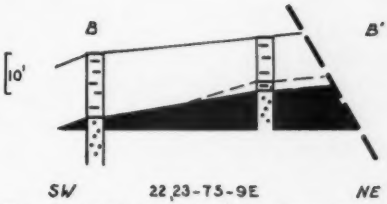

FIG. 3.—B-B′, cross-section of pay zone cut by fault.

by structure, conspicuous deviations of the production pattern from the structure pattern indicate the presence of another significant factor—depositional variations.

The shaly zone above the pay is of variable thickness. Changes in its thickness accentuate or nullify the effect of structure in forming traps. If the shale interval is fairly constant, the pay is high where the structure is high—as in the structural trap shown in figure 2. If the shale thins where structure is low, the pay there may be high. In sec. 3, T. 7 S., R. 9 E. (figure 4) such variation of shale thickness is sufficient to form a trap where the structure is low. Producers are structurally low, dry holes that produce water are structurally high.

Another important depositional variation is a change in the permeability of the pay. The sandstone may become shaly or interbedded with numerous thin shale streaks; commonly the interstitial spaces of the sandstone are filled with siliceous cement; in sandstone that is poorly sorted, the smaller grains fill the spaces between the larger ones; the sandstone may be lenticular. Such permeability changes are typical of Illinois "oil sands," where lateral variation of beds occurs commonly within a few acres, often within a few feet.

The distribution of producing wells on the anticline in sec. 34, T. 6 S., R. 9 E. is a striking illustration of the effect of permeability change, figure 5. There are many producers on the northwest flank of the anticline and several on the crest. On the highest part of the structure, however, are several dry holes. Sample studies show the pay in these wells to be shaly or cemented. The tight zone, cutting across the anticline, forms an effective seal for the oil accumulated along the flank of the structure.

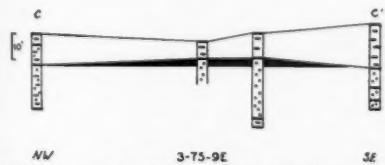

FIG. 4.—C-C′, cross-section showing effect of varying thickness of overlying shale on the trap.

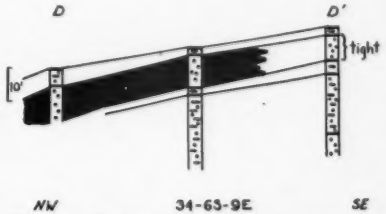

FIG. 5.—D-D′, cross-section of pay zone sealed by tight zone.

The small anticline in secs. 10 and 11, T. 7 S., R. 9 E. is a structure almost completely dry because of tightness of the sandstone. Only one well produces on this structure. The pay zone in the other holes on the anticline, though high, is shaly. The tested permeability of the sandstone in one of the highest wells averages only twelve millidarcies. Permeability of the pay in some producers in the pool averages eighty millidarcies.

These are primary features, related to conditions of deposition. In contrast, the structural features are the result of deformation.

Depositional variations on producing structures account for a number of dry holes throughout the pool.

Summary

Production from the Cypress sandstone in the Herald pool shows the effect of both structural and stratigraphic features on oil accumulation. There are examples in the pool of oil in the Cypress sandstone in the following types of traps:

Simple structural trap.
Trap sealed by an impervious bed at the fault contact.
Trap closed by thickening of overlying shale.
Trap sealed by a tight zone in the pay across an anticline.

There are also examples of areas high on structure which are dry because of depositional variations:

Thickening of overlying shale.
Tightness of producing sandstone.

TABLE 1. DATA FOR WELLS ON STRUCTURE MAP

Location Sec.-T.-R.	Spot	Company	Farm and Well	Depth to Base of Barlow	Surface Elevation	Subsurface Elevation: Base of Barlow	Producer or Dry Hole
26-6S-9E	SW NW SW	Angle-Gilpin	Marlin 1	....	412	.....	Dry
	SE NW SW	Angle-Gilpin	Marlin 2	....	389	.....	Dry
	NE SE SE	Gilpin	Marlin 1	2617	403	–2214	Dry
27-6S-9E	SE NW SE	Shaffer-Stoll	A. B. And 1	2645	440	–2205	Producer
	NE NW SE	Shaffer-Stoll	A. B. And 2	....	...	.....	Dry
	SW SE NE	Carter	A. G. And 1	2635	431	–2204	Producer
	SW NW NE	N. V. Duncan	A. G. And 1	2643	424	–2219	Dry
	SW NE SE	Shaffer-Stoll	A. G. And 1	2641	439	–2202	Producer
	NW NE SE	Stoll	A. G. And 4	2641	432	–2209	Dry
	SE SE NW	Skelly	E. T. And 1	2704	488	–2216	Producer
	NE SE NW	Skelly	E. T. And 2	2664	453	–2211	Dry
	SE NE SW	Pure	J. And A-1	2670	457	–2213	Dry
	SE SW SE	Pure	J. And A-2	2650	447	–2203	Producer
	SW SW SE	Pure	J. And A-3	2661	453	–2208	Dry
	NE NE SW	Bates & Lichlyter	M. D. And 1	2705	495	–2210	.....
	SE SW NE	Skelly	M. D. And 1	2660	446	–2214	Dry
	SW SW NE	Skelly	M. D. And 2	2686	469	–2217	Dry
	NE SW NE	Skelly	M. D. And 3	2639	427	–2212	Dry
	SW NE NE	Carter	Austin 3	2625	411	–2214	Dry
	NW NW NW	Pure	Austin-Wilson 1	2688	443	–2245	Dry
	NE SE SE	Angle-Gilpin	Marlin 1	....	432	.....	Dry
	SW SE SE	Gilpin	Marlin 1	2605	410	–2195	Producer
	NW SE SE	Gilpin	Marlin 2	2624	424	–2200	Dry
	SE SE SE	Gilpin	Marlin 4	2614	415	–2199	Producer
28-6S-9E	NE NE SW	Amsco	Austin 1	2721	451	–2270	Dry
33-6S-9E	SE SE NE	Carter	And 1	2717	510	–2207	Dry
	NE SE SE	Pure	Holland 1	2736	538	–2198	Producer
	SE SE SE	Pure	Holland 2	2720	521	–2199	Producer
	SE NE SE	Yoder	Holland 4	2719	517	–2202	Producer
	SE NE SE	Yoder	Holland 4-A	2718	517	–2201	Producer
	NE NE SE	Yoder	Holland 5	2720	515	–2205	Producer
34-6S-9E	SE NW NW	Pure	Austin Consol. B-1	2704	496	–2208	Dry
	NW SE SW	Pure	Holland A-1	2694	516	–2178	Dry
	NE SW SW	Yoder	Holland 1	2695	508	–2187	Producer
	NW SW SW	Yoder	Holland 2	....	499	.....	Producer
	NW SW SW	Yoder	Holland 2-A	....	501	.....	Producer
	SW SW SW	Yoder	Holland 3	....	504	.....	Producer
	SE SW SW	Yoder	Holland 6	2687	501	–2186	Producer
	SE NW SW	Carter	McCallister 1	2722	532	–2190	Producer

TABLE 1.—DATA FOR WELLS ON STRUCTURE MAP—Continued

Location Sec.-T.-R.	Spot	Company	Farm and Well	Depth to Base of Barlow	Surface Elevation	Subsurface Elevation: Base of Barlow	Producer or Dry Hole
	SW NE SW	Carter	McCallister 2	2709	530	–2179	Producer
	SW NW SW	Carter	McCallister 3	2723	525	–2198	Producer
	NE NW SW	Carter	McCallister 4	2728	531	–2197	Producer
	NW NE SW	Carter	McCallister 5	2657	472	–2185	Producer
	NE NE SW	Carter	McCallister 6	2638	461	–2177	Producer
	NW NW SW	Carter	McCallister 7	2729	526	–2203	Producer
	SE SW NW	Yoder	McAllister 2	2727	524	–2203	Producer
	SW SE NW	Yoder	McAllister 3	2663	474	–2189	Producer
	SE SE NW	Yoder	McAllister 4	2618	436	–2182	Producer
	NE SE NW	Yoder	McAllister 5	2657	467	–2190	Producer
	NW SE NW	Yoder	McAllister 6	2702	504	–2198	Producer
	SW NW NE	Carter	Merritt 1	2632	453	–2179	Producer
	NW NW NE	Carter	Merritt 2	2643	452	–2191	Producer
	SE NW NE	Carter	Merritt 3	2606	429	–2177	Producer
	NE NW NE	Carter	Merritt 4	2619	429	–2190	Producer
	SW NE NE	Carter	Merritt-Webb C-80-1	2606	423	–2183	Producer
	NW NE NE	Carter	Merritt-Webb C-80-2	2628	429	–2199	Producer
	SE SW SE	Gilpin	Newcomb 1	2654	479	–2175	Dry
	SE NE NW	Texas	Pool 1	2635	448	–2187	Producer
	NE NE NW	Texas	Pool 2	2684	482	–2202	Producer
	SW NE NW	Texas	Pool 3	2647	445	–2202	Producer
	NW NW SE	Pure	B. Weasel 1	2638	463	–2175	Producer
	SW NW SE	Pure	B. Weasel 2	2649	478	–2171	Dry
	C SE NE	Carter	C. Weasel 1	2581	409	–2172	Dry
	SW SW NE	Carter	C. Weasel 2	2614	440	–2174	Producer
	NW SW NE	Carter	C. Weasel 3	2598	417	–2181	Producer
	NE SW NE	Carter	C. Weasel 4	2584	410	–2174	Producer
	NW SE NE	Carter	C. Weasel 5	2578	405	–2173	Producer
	SE SW NE	Carter	C. Weasel 6	2633	458	–2175	Dry
35-6S-9E	SE SE SW	Carter	And 1	2625	441	–2184	Dry
	C SW NW	Carter	Marlin 1	2638	456	–2182	Dry
	NE SW SE	McBride	Porter 1	2604	419	–2185	Dry
	SW NE NE	Slagter	Questell 1	2634	433	–2201	Dry
	C NW NW	Carter	Webb C-81-1	2593	397	–2196	Producer
1-7S-9E	SW NW SW	Kingwood	Pyle 1	2917	497	–2420	Dry
2-7S-9E	NW SW NW	Kingwood	Bayley 1	2690	510	–2180	Dry
	SE SW SE	McCummings	Bayley 1	2668	481	–2187	Dry
	330SL, 410WL, NE SE	McGraw-Simon	Dagley 2		492		Dry

Location Sec.-T.-R.	Spot	Company	Farm and Well	Depth to Base of Barlow	Surface Elevation	Subsurface Elevation: Base of Barlow	Producer or Dry Hole
2-7S-9E	NW SW NW	Kingwood	Bayley 1	2690	510	−2180	Dry
	SE SW SE	McCummings	Bayley 1	2668	481	−2187	Dry
	330SL, 410WL, NE SE.	McGraw-Simon	Dagley 2	....	492	.....	Dry
3-7S-9E	SW NE NE	Gilpin	And 1	2667	490	−2177	Dry
	SW NE SE	McBride	And 1	2655	472	−2183	Dry
	NW NW NW	Carter	Bayley 1	2673	480	−2193	Producer
	NE NW NW	Carter	Bayley 2	2669	474	−2195	Dry
	NW SW NE	Gilpin et al	Bayley 1	2670	494	−2176	Producer
	SW SW NE	Gilpin	Bayley 2	2669	488	−2181	Dry
	NW NW SE	Gilpin	Bayley 3	2680	497	−2183	Producer
	SW NW SE	Gilpin	Bayley 4	2670	493	−2177	Producer
	SE NW SE	Gilpin	Bayley 5	2669	495	−2174	Producer
	580SL, 580WL, SE	McBride	Bayley 1	2675	491	−2184	Producer
	SW SE SE	McBride	Bayley 2	2666	477	−2189	Dry
	NW SW SE	McBride	Bayley 3	2697	510	−2187	Producer
	NE SW SE	McBride	Bayley 4	2673	490	−2183	Producer
3-7S-9E	NW SW NW	Q. B. Mitchell	Fulkerson et al-1	2722	530	−2192	Producer
	SE SE SW	Tidewater	Millikan 1	2659	470	−2189	Dry
	NE SE NW	Fox & Fox	O'Neal 1	....	496	.....	Dry
	SE SE NW	Fox & Fox	O'Neal 2	2677	491	−2186	Dry
	NE NE SW	Kingwood	O'Neal 1	2677	493	−2184	Dry
	SE NE SW	Kingwood	O'Neal 2	2682	497	−2185	Dry
	NE NW SW	Mitchell	O'Neal 1-B	2708	519	−2189	Dry
4-7S-9E	NE NE NE	Pure	Holland B-1	2726	528	−2198	Producer
	NE SE NE	Pure	Holland B-2	2709	514	−2195	Dry
	560SL, 560EL,	McBride	Millikan 1	2640	441	−2199	Dry
	SW SW NE	Carlson	Orr-Fulkerson	....	515	.....	Dry
10-7S-9E	NW SE NE	Kingwood	Bayley 1	2614	438	−2176	Dry
	SE SE NE	Kingwood	Bayley 2	2612	436	−2176	Dry
	NE NE NW	Shulman Bros.	Bayley 1	2643	454	−2189	Dry
	NE NW NE	Mabee	Harris 1-A	2652	472	−2180	Dry
	SW NE NE	Carter	Hendrix 1	2624	444	−2180	Dry
	NE NE SE	Kingwood	Knight 1	2614	439	−2175	Dry
	SE NE SE	Kingwood	Knight 2	2617	444	−2173	Dry
	NE SE SE	Kingwood	Knight 3	2612	434	−2178	Dry
	SW NE SE	Kingwood	Knight 4	2613	432	−2181	Dry
	SW SW SE	Mabee	Knight 1	2608	417	−2191	Dry
	NE SW NE	Carter	Weas 1	2623	436	−2187	Dry
11-7S-9E	NW NW SW	Gulf	Bayley 1	2607	430	−2177	Dry
	SW NW SW	Gulf	Bayley 2	2603	427	−2176	Dry
	NW NE SW	Gulf	Bayley 3	2617	438	−2179	Dry
	NW SW SW	Gulf	Bayley 4	2598	419	−2179	Dry

TABLE 1.—DATA FOR WELLS ON STRUCTURE MAP—Concluded

Location Sec.-T.-R.	Spot	Company	Farm and Well	Depth to Base of Barlow	Surface Elevation	Subsurface Elevation: Base of Barlow	Producer or Dry Hole
	NE NE SW	Gulf	Bayley 5	2613	432	–2181	Dry
	NW SW NW	Kingwood	Bayley 3	2637	462	–2175	Dry
	NW NW SE	Leach	Bayley 1	2607	424	–2183	Dry
	SW NW SE	Leach	Bayley 2	2619	431	–2188	Dry
	SW SW NE	Carter	Dagley 2	2623	437	–2186	Dry
	NE NE NW	Bennett Bros.	Questell 1	....	479	.....	Dry
	SW SE NW	Lewis	Questell 1	2622	442	–2180	Dry
	SE SE NW	McCummings	Questell 2	2617	438	–2179	Producer
	300NL, 330EL, NE NW	McCummings	Questell 6	2662	482	–2180	Producer
12-7S-9E	SE SE SW	Wilson	Dagley 1	2745	417	–2328	Dry
14-7S-9E	NE SW SW	Oil Management	Bayley 1	2577	407	–2170	Producer
	SE SW NW	Oil Management	Harrell 1	2606	433	–2173	Dry
	SW SE NW	Oil Management	Harrell 3	2603	423	–2180	Dry
	NW SE NW	Oil Management	Harrell 4	2617	439	–2178	Dry
	SE NW NW	Carter	Knight 1	2618	432	–2186	Dry
	NW NE SW	Oil Management	Williams 1	2634	394	–2240	Dry
	SE NW SW	Oil Management	Williams 2	2578	405	–2173	Dry
	NE NW SW	Oil Management	Williams 3	2582	404	–2178	Producer
	NE NE SE	Spires	Williams 1	2719	396	–2323	Dry
15-7S-9E	SE SE SE	Phillips	Bourland 1	2633	445	–2188	Dry
	SE SE NE	Phillips	Bourland 2	2591	402	–2189	Dry
	SW SW NW	Anderson	Knight 1	2603	400	–2203	Dry
	NE NE SW	Self	Knight 1	....	412	.....	Dry
21-7S-9E	NE NE NE	Skelly	Hale 1	2611	404	–2207	Dry
	NE SE SW	Ryan	Mills 1	2596	387	–2209	Dry
22-7S-9E	SW NE SE	Aetna & Oil Management	T. H. Boyd 2	2607	411	–2196	Dry
	NE NE SE	Aetna & Oil Management	T. H. Boyd 4	....	402	.....	Producer
	SE NE SE	Aetna & Oil Management	T. H. Boyd 5	2586	401	–2185	Producer
	NW SW SW	Carter	Hale 1	2632	413	–2219	Dry
	NE NE NE	Fryer	Jones 1	....	428	.....	Dry
	SE SE NE	Oil Management	Jones 2	2593	414	–2179	Producer
	NE NE NW	N. V. Duncan	Knight 1	2613	412	–2201	Dry
23-7S-9E	SW NW NW	Fryer	C. H. Boyd 2	2588	399	–2189	Dry
	NW SW NW	Red Bank	C. H. Boyd 1	2567	394	–2173	Producer
	SW SW NW	Red Bank	C. H. Boyd 2	2568	390	–2178	Producer
	SE SW NW	Red Bank	C. H. Boyd 3	2709	389	–2320	Dry
	SW NW SW	Claude Neon Lights	T. H. Boyd 2	....	390	.....	Producer
	NW NW SW	Red Bank	T. H. Boyd 1	2571	390	–2181	Producer

PSYCHOLOGY AND EDUCATION

EDUCATIONAL PLANS OF ILLINOIS HIGH SCHOOL STUDENTS IN RELATION TO FINANCIAL SITUATION AND ACADEMIC APTITUDE

DON THOMANN
University of Illinois, Urbana

This report is concerned with the plans of Illinois high school juniors and seniors to continue their formal education beyond the high school level; with their ability, both scholastic and financial, to make these plans effective; and with the implications which arise out of the findings, both for our public educational system and for society at large.

The data for this study were collected by the High School Testing Bureau at the University of Illinois, which each year directs the Illinois statewide testing program. The data include: first, the information supplied by the juniors and seniors themselves concerning their plans for continuing formal education beyond the high school level; second, the report which the high school principal makes on each student concerning his scholastic promise and his financial ability to continue education after high school graduation; and, third, the scores which each student makes on the American Council on Education psychological examination. This test is primarily a measure of scholastic aptitude and is often used for guidance purposes in appraising the student's likelihood of success at the college level. It might be noted here that students' plans to continue formal education beyond the secondary school include plans for attending business college, vocational and trade schools, the junior college, or other types of educational institutions as well as the standard four-year college and university.

Almost two thirds of the public and private high schools in Illinois, exclusive of the public schools in Chicago, participate in the Illinois statewide testing program. Most high schools test at the junior level, so that data on well over 30,000 junior students are available each year. The Bureau also receives data each year on approximately 8,000 senior students. It is these juniors and seniors, or representative groups of them, on which the figures in the present report are based.

Students' Plans

Of the high school juniors who participated in the statewide testing program during the current year, approximately 2,000 were selected on a stratified sampling basis as representative of the total group. The responses of these students show that approximately 66 percent have plans for continuing education beyond the high school level. Thirty-three percent do not plan to seek further education, while about 1 percent are undecided. A breakdown by sex shows no statistically significant difference in these figures and would indicate that sex is not an important factor in determining whether a student will plan to con-

tinue with his formal schooling. The direction of difference, however, favors a slightly greater proportion of junior girls than of junior boys who plan to continue.

Data from three previous years, two of them since the war and one while the war was at its height, show only slightly lower percentages of junior students who plan to continue education beyond the high school than are shown in the figures of the current year. These figures range from 58 to 62 percent for the boys and from 62 to 65 percent for the girls. In other words, there is little variation in the percentage of juniors each year who plan to continue their formal education, although that variation which does exist points in the direction of an increase which currently includes almost two-thirds of all junior students in Illinois high schools.

The educational plans of high school seniors have not yet been studied for the present year, but data from previous years indicate that what is true for the juniors is generally true for the seniors as well. A slightly greater proportion of senior boys than of junior boys plan to continue with their education, for at this level the figures range from 60 to 65 percent. On the other hand, a slightly smaller proportion of senior girls than of junior girls have further educational plans, so that in the senior group the proportion of boys who plan to continue education after high school graduation is slightly greater than the proportion of girls, though the difference is still not statistically significant. It is safe to generalize that among both boys and girls, at both the junior and senior levels, approximately two thirds of all Illinois high school students plan to carry on school work beyond the secondary level.

Scholastic Aptitude

How do these students with plans for further education stand scholastically? Are those who are most able to benefit by continuing education beyond high school the ones who plan to do so? These questions are important ones to ask if we are concerned with an educational system that meets the needs and abilities of every student and one that serves the best interests of society by preparing for responsible professional and leadership positions all those who have the ability to function at such levels in society.

When we consider the report made by the high school principal on each student in the statewide testing program, we find there is a definite positive correlation between the scholastic promise of students and their plans for continuing education. In the current year approximately 83 percent of all junior girls planning further education are reported as possessing scholastic promise, whereas, only 49 percent of the girls not planning further education are so reported. Among the junior boys the percentages are somewhat lower, being 70 percent of those planning to continue education and only 29 percent of those not planning to continue. The figures from former years are similar, in every case a higher percentage of girls than boys being reported as showing scholastic promise and a higher percentage of those with plans for further education than of those without plans being so reported. In every case, too, the percentage of those showing scholastic promise is higher for senior students than for juniors. The picture is always the same, however, in showing a considerably higher proportion of students with scholastic promise among those who plan to continue their education beyond the secondary school level than

among the group of students who do not have such plans.

Another way of determining the student's aptitude for scholastic achievement beyond the high school level is the score he makes on the American Council psychological examination, which is used in the statewide testing program. Current figures show that of those junior students who plan to continue education approximately 68 percent are in the upper half of scores on the A.C.E. psychological test. Only 37 percent of those who do not plan to continue stand in the upper half on the test. Putting it another way, of those students who stand in the upper half on test scores approximately 78 percent plan to continue education as compared with only 49 percent of those who stand in the lower half on test scores. These figures vary somewhat from group to group but remain substantially the same for both boys and girls and for both junior and senior students. Likewise, they are fairly constant over a period of several years, although a slight trend might be noted in the direction of an increased number planning to continue education both among the group in the upper half on test scores and among the group in the lower half.

The significant fact in the figures presented thus far is not that those students who plan to continue education beyond the high school level are predominantly the ones who possess scholastic promise or stand high on test scores. That is not an unexpected discovery. But it is important to note that from 30 to 50 percent of those students who *do not plan* to continue further education possess the ability and promise of doing successful work at the college level. What is the reason that such a large proportion of students have no plans for pursuing further education even though they have the ability to do so, and even though our educational system purports to meet individual and societal needs by offering the maximum opportunity for development to all individuals?

Financial Ability of Students

Perhaps one answer to the question just asked lies in the financial ability of students to continue schooling beyond the high school level. Our principals' reports show that over 45 percent of all students are not able financially to continue with their education after high school graduation. Undoubtedly a large number of these also lack the scholastic ability or promise that would make it desirable for them to go on with advanced education. But the reports indicate that of those students who are rated as possessing scholastic promise, an average of over 35 percent, or one in three, does not have the financial ability to continue his education beyond high school. Of those students who stand in the upper half on the A.C.E. psychological test, approximately one third are reported from families whose financial situation does not encourage them to make plans for further education.

We can look at the figures in another way by comparing the group who have educational plans with the group who do not have such plans. In the latter group there is approximately twice as great a percentage reported as having scholastic promise but lacking in financial ability as there is in the group planning to continue education. Among the students who rank in the upper half on the A.C.E. test, over 60 percent of those who do not plan to continue are financially unable to do so, whereas less than 30 percent of those who do plan to continue education are reported in unfavorable financial circumstances. These

figures would seem to indicate that lack of financial ability is one of the major reasons why many high school students do not plan to continue their education beyond the secondary level, even though they possess the scholastic promise and aptitude for doing successful work at a higher level.

Democratic Implications

The figures presented thus far tell a story that carries meaning for our schools and for the community and nation at large. At the local school level the question of individual pupil guidance concerning educational matters involves: how especially to assist and encourage the student to continue with his education when he has the scholastic promise and ability but has made no plans to carry on beyond the high school level; how, too, to help the individual student overcome problems which stand in the way of continuing his education because of financial circumstances that are unfavorable to his continuance. These are problems that are local and specific in nature, but above and beyond them are more important problems which concern our entire educational program and the part that our educational system plays in the society in which we live.

The fundamental purpose of the schools in a democratic society is promotion of the maximum development of every individual to the end that both individual and group welfare are served in the greatest possible extent. If democracy is to triumph over communism and other forms of totalitarian society, it must do more than pay lip service to its ideals. As a nation we cannot afford to squander human resources by failing in our schools to achieve the optimum development of every individual in order that he may contribute his best to our democratic way of life. Yet when we find that over one third of our young people who possess capacities for growth and development beyond the high school level are unable to make plans for continuing their education because of financial reasons, we realize that our educational system has a long way to go to meet individual needs and a long way to go to fulfill its function in society.

The schools alone are not to be blamed, but educators themselves have the major responsibility in thinking through the problem and promoting an adequate solution for it. Our educational system may have to be expanded until the junior college becomes recognized as a fundamental part of the free public school structure. It may be necessary to establish educational benefits for civilian youth, as President Stoddard of the University of Illinois has suggested, in order to provide an advanced educational program for all those who can benefit by it, regardless of their financial circumstances. Certainly the problem is one which concerns our national government as well as the states. It is a problem for all of society to ponder, for it involves the fundamental democratic issue of whether every individual can expect to achieve maximum personal growth and development or whether some, because of the circumstances into which they fall or are born, cannot expect the same opportunities and advantages as others.

The Illinois State Academy of Science is already recognizing the problem to a limited extent through its participation in the science talent search, which is sponsored each year by Westinghouse. The Academy endeavors to secure scholarships in Illinois colleges and universities for top-ranking high school science students who have entered the national

competitive program but have not been selected at that level. This effort is an example of what can be done in selecting students who show outstanding promise and giving them the opportunity and encouragement to go on. It is a limited effort, however, for it is restricted to students interested only in the various fields of science. It does not purport to recognize financial need as one of the factors in the selection of students for scholarships, although in some cases, undoubtedly, selection for a scholarship provides the opportunity without which talented students could not plan to continue their education. Perhaps a program of selection might be worked out which would give greater recognition to financial need but at the same time maintain present high standards in the recognition of science ability. Perhaps, too, the program could be adopted by other state and national groups for granting recognition and aid to promising students in fields other than science. In this way, we might at least alleviate the situation by providing greater opportunity for outstanding students regardless of their financial circumstances.

In this paper, however, I do not presume to find an answer to the problem. I only wish to call to your attention that a problem does exist, and that our democratic values and welfare as a nation will suffer until a solution is found. The problem remains one of promoting greater democracy and the social good by finding an answer which will enable all high school students who possess scholastic ability to continue with their education at an advanced level without regard to their financial ability to carry them through such a program.

SOCIAL SCIENCE

ADMINISTRATIVE PROBLEMS OF TOWNSHIP GOVERNMENT IN DU PAGE COUNTY

HAROLD GORDON
Wheaton College, Wheaton

Within Du Page County, Illinois, there are nine township governments each of which has an independent existence. They are all similar in organization and area and provide practically identical services. Some of these townships have become almost entirely urban areas, while others remain predominantly rural in their population and attitudes. Basically there is no discernable difference in the services provided by the two types. Both are interested primarily in the building and maintenance of roads, the distribution of poor relief, and the assessing of property for tax purposes. In addition to these basic interests there are other minor functions which vary from township to township.

TABLE I.—POPULATION CHARACTERISTICS[a]

York, Naperville and Winfield Townships, DuPage County, Illinois

Township	Total Population	Rural %	Urban %
York	29,161	7.1	92.9
Naperville	3,616	28.9	71.1
Winfield .	6,857	42.8	57.2

(a) Source: U. S. Bureau of Census; 1940 Census, Vol. I, Population, p. 299.

The primary function of the township is to act as an administrative district for the county and state governments. The county depends upon the township for an accurate assessment of property. This assessment is used as the basis for determining all tax rates within the county. In addition to providing the county with an assessment, the township is used as an election district for all county, state, and national elections.

The relations of the township are not confined to the county but extend as far as the state government and even, in some instances, as far as the national government. This latter extension of relations deals primarily with roads while the former deals with both roads and poor relief.

There are a great many functions provided by statute which the township is supposed to perform. Some of these are: repairing roads and bridges; maintenance of town cemeteries; care of the poor and indigent; preventing growth and spread of noxious weeds; promoting planting and cultivation of trees along highways; making rules and regulations concerning fences; preventing the running at large of cattle, horses, mules, asses, swine, sheep and goats; establishing and maintaining pounds; repairing and regulation of public wells, etc.[1] Today, about the only functions actually carried on by the township are the maintenance of roads, the care of the poor and indigent, and the assessment of property. The other functions, while

[1] *Illinois Revised Statutes*, 1945.

still in the statutes, are either obsolete or simply ignored.

The affairs of the township are administered by elected township officers, each of whom attends to the duties assigned him by law and cooperates with the other officers when it is necessary. The supervisor of the township is the general administrative head and also treasurer. He is, in addition, a member of the county board and ex-officio overseer of the poor. The other elective officers of the township are the township clerk, assessor, highway commissioner, and justices of the peace. A board of auditors composed of certain of these town officers is established to examine the township accounts. Most of the elected officers are paid on a per diem basis. The per diem rate is set by state statute. The supervisor is eligible to receive two separate payments; a per diem as supervisor and a salary as overseer of the poor.

The necessary funds for the operation of the township are appropriated by the voters at the annual town meeting. The township budget is the financial plan for operating the township during the fiscal year. The official budget is drawn up by a budget committee, usually the board of town auditors, sometime prior to the time set by law for the town meeting. At least one public hearing is held on this budget prior to final action by the people at the town meeting. Notice of the hearing is given one week prior to the time set. This public hearing is often called for one hour prior to the town meeting. Because of this practice there is little real opportunity for an interested citizen to bring any effective protest concerning the budget. At the meeting copies of the budget are not available for examination and when it is read by the town clerk, as required by law, it is frequently read so rapidly that it is impossible to obtain adequate notes. After the budget is read, there is opportunity for the town's people to ask questions, or to propose amendments to the budget. Questions are seldom asked or amendments proposed, for the people present usually do not know enough about the budget to ask questions. If any citizen or group of citizens did wish to make a change, it would be illegal for them to propose an alternate budget. The only recourse that the citizens have is to amend the official budget. This method allows the revision of specific items, but a general revision by this procedure is practically impossible.

After opportunity for discussion and amendment the proposed budget is put to a vote. It takes only a simple majority of the voters present to pass the budget. This vote must either accept or reject the budget as a whole. If the voters present fail to approve a budget there can be no legal expenditure of any funds by the township officers. If the budget is accepted, there must also be voted a levy authorizing the procurement of the funds necessary to execute the budget, unless there is a sufficient balance left on hand from the previous year.

The argument most frequently advanced in support of township government is that it gives the people a chance to exercise direct democracy—that the people have an opportunity to come together once a year and either approve or disapprove of their elected officers' actions. This is certainly in accord with the very best democratic traditions of our country and in the past the town meeting was one of the political highlights of the year. However, today in actual practice, the people either are not interested in their democratic privileges or they do not feel close to their township government. An average of

TABLE II.—ATTENDANCE AT TOWN MEETINGS [a]

Du Page County, April 1947

Township	Number of Registered Voters	Attendance	Per Cent Attending Meeting
Addison	6,796	17	0.25
Bloomingdale	[b]1,704	(c)	(c)
Downers Grove	16,742	23	0.14
Lisle	4,841	28	0.58
Milton	12,176	50	0.41
Naperville	2,222	16	0.72
Wayne	775	12	1.55
Winfield	4,522	15	0.33
York	19,830	194	0.98
Totals	[b]67,904	355	0.51

(a) Source: Natale, Joseph, *Local Government in Du Page County, Illinois*, p. 184.
(b) Bloomingdale not included in total.
(c) Data not available.

less than one-half of one percent of the registered voters in Du Page County attended the meetings in 1947. From the incomplete figures available for 1948 it appears that this percentage will be even lower.

The budget adopted by the town meeting generally provides for two separate funds: the town fund and the poor relief fund. The town fund includes such items as compensation for elected officials, election expenses, and all other general administrative expenses of the township. The poor relief fund includes the funds necessary for the relief of the poor and for its administration, except the compensation for the overseer of the poor which is included in the town fund.

Funds for the maintenance of roads are obtained through a separate budget which is adopted in an entirely different manner. This budget is drawn up by the highway commissioner and then presented to the town clerk who calls a special road and bridge hearing. This hearing is set for some time other than that of the town meeting. A favorite time is 10:15 on a weekday morning, thus making it inconvenient for persons to attend. Even if interested citizens should attend the hearing there is no way of forcing the commissioner to amend his proposed budget.

Since the road and bridge fund accounts for such a large proportion of the total town expenditure, 44.2 percent, it would seem reasonable

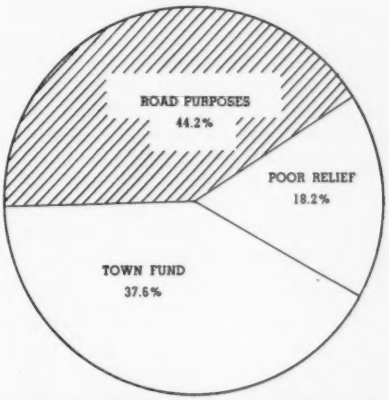

FIG. 1.—Use of funds. Source: J. P. Natale, Local Government in Du Page County, Illinois, p. 43.

that it be drafted by a more representative group. In addition it would seem only natural that it should be acted upon at the town meeting when there are apt to be at least a few voters present.

The full authority to contract bills and authorize specific expenditures lies with the township supervisor. The only exception to this is in the case of the road and bridge fund where the highway commissioner has this contractual authority. Thus the supervisor is the possessor of a large amount of financial authority. The electors of the township approve a budget at the annual town meeting, but once the appropriation is made, the actual expenditure of the money is left in the hands of one man.

Theoretically there are checks upon the supervisor's fiscal activity. One check is found in the board of town auditors, which has authority to examine and audit all charges against the township and to examine the accounts of the overseer of the poor. It will be noticed, however, that while authority is given to audit the charges against the town, there is no authority for this board to audit the township or poor relief accounts; they may merely examine them. Consider the composition of this board. It consists of the supervisor, whose accounts are being reviewed, the township clerk and the justices of the peace. All of these are elected officials. There is not one outside impartial member on the board nor one representative of the taxpayers. It can easily be seen that the probability of a good sound review is certainly open to question. The other check is in the town clerk. The town clerk must countersign all warrants issued by the supervisor. By this counter signature the clerk is supposed to attest to the validity of the warant, but there is some question that he really has the authority to hold up an expenditure authorized by the supervisor.

We have noted earlier a rather lengthy list of duties which have been given by statute to the township. We also saw that of this lengthy list only three or four are actually performed. This discrepancy is the result of a change of emphasis on the part of township government. In the early history of the state, many of these functions were a real necessity and were actively administered. For example, the law provides that the township shall see that all fences bordering township roads are mended. This, in the days when farmers in the area kept large amounts of live stock was very important. Today, with many of the townships predominantly u r b a n, this practice has fallen into disuse.

In another instance the law provides that the township shall repay farmers for any damage to livestock caused by wild dogs. To combat this menace the office of town poundmaster was created. The poundmaster was charged with the duty of apprehending any and all wild dogs found on town property. Today, the danger to livestock from wild dogs is almost non-existent in Du Page County. However, in many of the townships the office of poundmaster is still a thriving institution with an annual appropriation for salary and expenses. Thus here and in many other instances, there is ample opportunity for the elected official to provide himself with extra funds or to provide patronage for his faithful friends.

On the other side of the picture we have instances where these antiquated township statutes have created hardship. For example, take the matter of highways. In 1920 York Township had some 40 miles of roads to maintain. The tax rates were set to produce ample funds for

this operation. Today, this same township has 80 miles of roads to maintain. Thus the number of miles of road has been doubled. In addition to the doubled mileage, the type of road which must be provided for modern transportation is much more expensive. Yet, with all this increase in operating costs, there has been no corresponding increase in the tax revenue to provide the necessary additional funds. The authority for this increase in revenue would have to come from the state legislature.

In contrast, Naperville Township has increased its roads from 40 miles in 1920 to only 44 miles today, so that its problem is not nearly so vexing.

When we come to examine specific budgets and specific expenditures we find many things that make our task difficult. In the first place, there is no uniform system of bookkeeping or accounting among the townships. This makes the matter of interpretation difficult unless the supervisor is willing to explain his particular system. Then when comparisons are attempted there is further difficulty in placing expenditures under comparable headings, since expenditures for identical items may be listed under widely different titles.

The first thing noted in an examination of township finances is the varying tax rates. Furthermore, the township levies have steadily increased in many instances. In Naperville Township for example, the levies per thousand dollars valuation increased from sixty three cents in 1942-43 to one dollar in 1946-47. In Addison Township the levies increased from thirty-eight cents in 1942-43 to ninety cents per thousand in 1946-47. There seems to be no good reason for this difference in rates since the services performed are similar in all the townships and are similar from year to year.

Let us examine now, the expenditures of two typical townships. Two townships were chosen which, from a general overall view, appeared to be representative of the urban and rural townships of the county. Naperville Township was chosen to represent the rural. Its population is in large part rural, there being only half of one incorporated village within the township limits. It also has the reputation of possessing a good, clean township government whose officials are businessmen of high reputation in the community. In contrast, the urban township of York was chosen. York township government is known to be in the hands of professional politicians who obtain their livelihood from their political jobs.

In 1947-48 Naperville Township spent $4,792.61 on its town fund while York Township spent $33,-

TABLE III.—TOWNSHIP LEVIES [a]

Per Thousand Dollars Valuation
1942 to 1947

Township	1942-43	1943-44	1944-45	1945-46	1946-47
Addison	$0.38	$1.05	$1.07	$0.66	$0.90
Lisle	1.38	1.29	1.26	1.22	1.40
Naperville	0.63	0.57	0.95	0.97	1.00
York	0.56	0.57	0.45	0.56	0.50

(a) Source: J. P. Natale, *Local Government in Du Page County, Illinois*, p. 41.

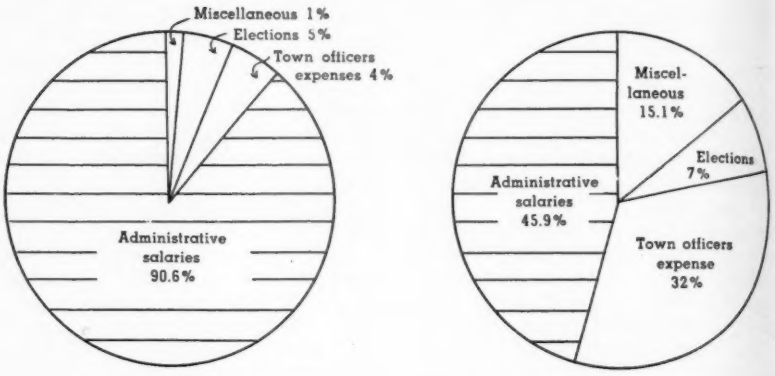

FIG. 2.—How the town fund tax dollar was spent in Naperville and York townships, 1947-1948. Source: Township records.

068.23. Thus it is readily seen that the expenses of the urban township are far greater than those of the rural. Yet the services performed by the two units are identical.

A look at the individual items of expense reveals that in Naperville 90.6 percent of the total town fund expenditure went for compensation of elected town officers. In York Township only 45.9 percent of the total town fund went for such purposes. The elected officials of the townships receive compensation for regular and special services. The amount of this compensation is set by state statute. The seemingly large expenditure for compensation in Naperville is explained by the fact that the state sets the rate at which officers must be paid. This rate of compensation thus becomes a fixed overhead cost which must be carried by all townships, irrespective of their size, and the smaller the population the larger the percentage of total expenditure this fixed overhead becomes.

But look at the other items of expenditure in the town fund. Exclu-

TABLE IV.—TOWN FUND [a]

York and Naperville Townships
1947-48

Purpose	Naperville	York
Total	$4,792.61	$33,058.23
Compensation of town officers	4,352.15	15,184.12
Elections	217.00	2,588.90
Town officers expense	193.46	10,654.26
Interest on anticipation warrants		596.49
Miscellaneous services	30.00	4,034.46

(a) Source: Township records, Naperville and York Townships.

TABLE V.—POOR RELIEF FUND [a]

Expenditures by Purpose
York and Naperville Townships
1947-48

Purpose	Naperville	York
Total	$2,476.25	$15,270.08
Home relief	1,058.96	7,944.69
Hospitalization	540.61	3,008.03
County home	876.68	1,330.12
Transient pauper relief	.....	170.42
Burial of poor	.....	110.00
Administrative costs	.....	2,706.82

(a) Source: Township records, Naperville and York Townships.

sive of the officers compensation, it costs the citizens of Naperville practically nothing to run their township government. Take for example, the "town officers' expense." This account includes such things as stationery and office supplies, printing and publishing, office help, rent, office equipment, travel and transportation. All of these things cost the citizens of Naperville slightly under two hundred dollars or 4 percent of the total expenditure for the year. In York township the bill was nearly eleven thousand dollars or 32 percent of the total expenditure for the year. Even allowing for the larger population in York, this seems to be greatly out of proportion. A brief glance at the poor relief fund (Table V) will reveal the same situation. Here, where we are able to get an exact administrative cost exclusive of compensation to the overseer of the poor, we find that it cost the citizens of Naperville exactly nothing to administer their poor fund while the people of York had to pay twenty-seven hundred dollars.

Now that we have seen some of the expenditures for our two townships let us look at the per capita costs of these two units. As we do this, keep in mind the fact that Naperville is run by businessmen who are not politicians in the usual sense of the word, but are men of high business standing who have the good of the community at heart. On the other hand, York is run by professional political machines. The first thing we note is that the total per capita cost of township government, exclusive of roads, is two dollars per person in Naperville while only one dollar and sixty-five cents in York. (See figure 3 on page 98.) Considering conditions as they are known to exist, this does not seem logical. However, when we break these total figures down we once again see that it is the compensation of town officials which forces the figures out of line. If we look at the town fund expenditures, exclusive of compensation, we find the per capita cost in Naperville to be twelve cents as against sixty-one cents for York. This gives us a much truer picture of the conditions as they actually are.

If we wish to check our figures we may use as a basis of comparison $1000 valuation of assessed property. When we do this, we find that our results are similar. They once more point to the high per capita

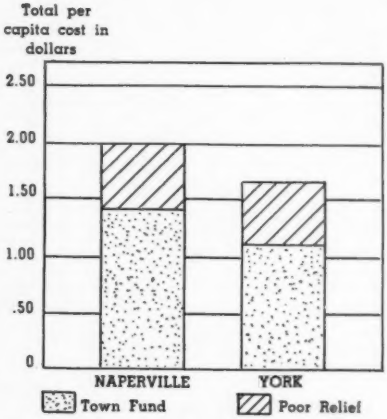

FIG. 3.—Per capita cost of government, Naperville and York townships, 1947-1948. Source: Township records.

costs of officers compensation in Naperville and the exceedingly high running expense in York.

Briefly, let us consider the administrative costs as compared to the value received for the expenditure of the poor relief fund. In York Township the total expenditures for poor relief were $15,270.08. To administer this money it cost the tax payers $5,587.52. Thus, in order to get one dollar into the hands of the poor it cost thirty six and one-half cents. Slightly more than one third of the entire poor relief fund went for purposes of administration.

In contrast look at Naperville. Here $2,476.25 was spent for relief and there were no administrative costs. Thus the tax payers received 100 percent value for their tax dollars.

This is quite a contrast. You may well wonder how Naperville reached this state of perfection. You will remember that the town supervisor also serves ex-officio as overseer of the poor. In Naperville the supervisor drew his state allowed compensation. However, he refused to draw any compensation as overseer of the poor since he felt that the remunera-

TABLE VI.—PER CAPITA AND PER $1000 VALUATION COSTS TOWN FUND [a]

Naperville and York Townships
1947-48

Purpose	Per Capita [b]		Per $1000 Valuation [b]	
	Naperville	York	Naperville	York
Total	$1.32	$1.13	$32.20	$23.40
Compensation of town officers	1.20	.52	30.00	10.00
Elections	.03	.09	$1.00	$2.00
Town officers expense	.05	.36	1.00	8.00
Interest on anticipation warrants	...	.02	...	.40
Miscellaneous services	.01	.14	.20	3.00
	.12	.61	2.20	13.40

(a) Source: Township records, Naperville and York Townships.
(b) NOTE: Population of Naperville 3,616
Valuation of Naperville $11,301,783
Population of York 29,161
Valuation of York $132,899,234

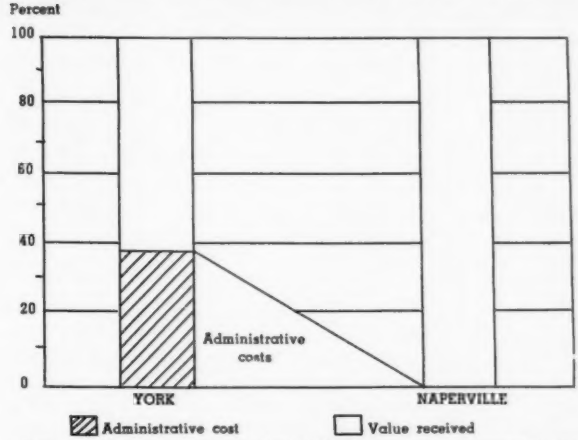

FIG. 4.—Percentage of administrative costs compared to value received, Naperville and York townships poor relief fund, 1947-1948. Source: Township records.

tion received as supervisor was more than ample pay for both offices. At the same time this man carried on his duties as overseer in his own store thus saving the township any overhead expense for office costs.

Nevertheless the fact remains that the per capita cost of township government in Naperville is exceedingly high. From these facts there is but one conclusion to be drawn. This is that the township unit of government cannot perform economically in such a small area and with such a small population. Township expenses are disproportionately high for overhead and low for services received. Compensation accounts for from one-half to nine-tenths of the townships' general expenditures. It has been shown in other studies of Illinois that, at a comparable service level, per capita costs of government were more than twice as great in counties with townships than in counties without townships,[2] and that "township organization adds to the cost of government without the addition of a commensurate service."[3] There is no government function performed by townships that other units of government could not perform more effectively.

There is almost universal agreement that abolition of the midwest townships would make for better rural government. The Committee on County Government of the National Municipal League, said:

> "The objections to the retention of township government are many. There is evidence that the township places a burden on the taxpayer for which there is no commensurate return in services rendered. The major functions of government essential in the rural areas cannot be maintained economically and efficiently by township units.... In the administration of justice, health and welfare, highways, and finance, the township is no longer a satisfactory unit.... Finally, the township is an artificial area which does not conform necessarily to trade or community areas."[4]

The brief study herein presented merely adds further evidence to the support of this contention.

[2] Hicks, H. S., *County Organization vs. Township Organization*, 1932, (Mimeographed pamphlet).
[3] Hunter, M. H., *Costs of Township and County Government in Illinois*, University of Illinois Bulletin No. 45, 1933, Vol. XXX, No. 18, p. 31.
[4] Bromage, A. W., *Recommendations on Township Government* (Report No. 3 of the Committee on County Government of the National Municipal League), Supplement to National Municipal Review, Vol. XXIII, No. 2, February, 1934, p. 139.

ZOOLOGY

A SUMMARY OF STUDIES ON THE AMBUSH BUG PHYMATA PENNSYLVANICA AMERICANA MELIN (Phymatidae Hemiptera)

W. V. BALDUF
University of Illinois, Urbana

Method of Study.—The data on the life cycle and natural foods were largely obtained in the field, whereas those regarding variations in the instars and the weight patterns were secured from captives. Eggs, laid by females swept from wild flowers in September-October and subsequently kept under natural conditions out-of-doors, yielded nymphs in January after exposure for 10 days to 80° Fahrenheit and about 80 percent relative humidity. Severe freezing and wetting proved necessary to produce hatching. The resulting nymphs and adults were kept individually in shell vials, each vial containing a strip of white blotting paper for support. The bugs were fed on quantitatively varied rations of adult *Drosophila melanogaster* L. and *Musca domestica* L.

Recognition and Life Cycle.—The adult is about 2/5 inch long and colored yellow, brown, and green, with a black band across the reposing wings. Being phlegmatic in temperament, it is readily weighed on the open pan of the balance. Adults may be found from July to October by searching the fresh flowers of various plants, especially mountain mint and Compositae. During this period the eggs are laid shingle-fashion in masses and covered with a golden flocculent matrix. I have not succeeded in finding the eggs in nature, but the females readily deposit them in the vials. Most adults die before November, leaving the eggs to bring the species through the winter. The nymphs hatch in May-June and complete their five instars by July. A feature of special interest is the delay in hatching. Although the embryo develops within the first 10 days after oviposition, it remains unhatched or dormant for nine months or less. Were this prolonged diapause eliminated, the species might realize two generations, instead of one, in a year.

Food and Feeding.—The adult may readily be seen sitting amid the floral parts with its anterior end elevated and alert to capture other insects that visit flowers to feed on nectar, pollen, petals and reproductive structures. As the flowers age and no longer attract its insect food, the bug flies to fresh flowers and more adequate prey. No proof was found that the predator chooses flowers whose colors tend to conceal it. The food insects present are obviously the factors that induce the bug to remain in the flower.

Both the nymphs and the adults are doubtlessly the most efficient predatory terrestrial Hemiptera in our area. They employ their extraordinary fore legs to seize their victims by the mouthparts, antennae, legs or even the wings. So powerful is *Phymata* that it can hold with one front leg a fluttering moth of superior size, and, in not a few cases, is found holding two captives simultaneously. However, the adult male

is decidedly less voracious than the somewhat larger, paler female, not only feeding less frequently but also, on the average, on smaller forms of insects.

Relatively small captives are quickly inactivated and their bodies observably enlarged as *Phymata* pumps a fluid into them through its piercing-sucking mouthparts. This fluid, presumably of a salivary sort, seems both to deaden the victim and to liquefy the non-chitinous viscera. Subsequently this dissolved matter is sucked out, leaving the discarded small prey very light in weight and the abdominal segments telescoped sharply inward.

In three years of field work, I removed 832 individual insects from the grasp of adult *Phymata*. These represented 195 species, 131 genera, 54 families and seven orders. Distributed taxonomically, the number of individuals taken were: Coleoptera, 82; Hymenoptera, 216; Lepidoptera, 134; Diptera, 346; Neuroptera, 1; Hemiptera, 52; and Homoptera, 1. All the victims were adults, excepting one small geometrid looper and three hemipterous nymphs of the families Miridae, Nabidae, and Pentatomidae.

Diet in Relation to Performance.—The relation between vital performance and quantity of food taken was studied by setting up series of 10 or 20 bugs in shell vials and providing varying numbers of *Drosophila* and *Musca*. Even the nymphs of the first instar quite readily capture the larger *Drosophila*. In some series *Musca* was supplied to the nymphs in the fourth and fifth instars and the adults. The biological effects of these differentiated diets proved to be measurable in the following terms: percentage of survival among the nymphs, length of the instars, rate of growth; weight, size, longevity, extent of sexual activity, and egg-production, among the adults. Six series of individuals were maintained on dietaries graduated from the minimum barely adequate to bring a few nymphs to adulthood, to an optimum which yielded biological results comparable with the normal performance of bugs in nature. For example, individuals that sucked out only 66 *Drosophila* required 187 days to complete the five instars, whereas nymphs that utilized the equivalent of 541 *Drosophila* grew to adulthood in an average of 50 days. Only one nymph of the low-fed series became adult,—a female, that lived but 15 days, weighed 0.0089 gram, and produced no trace of eggs. By contrast, 15 individuals of the above best-fed series became adults which lived an average of 68 days each; the pairs coupled and mated freely and the seven females among them produced slightly more than 100 eggs each and averaged 0.0602 gram in weight. The data from the intermediate series showed that a female must ingest about 120 *Drosophila* in the nymphal stage and about 225 during adult life in order to attain that state of vigor necessary to the inception of sexual activity and oogenesis. As the dietary was increased, the nymphal life became proportionately shorter, adulthood longer and the productive functions, weight and size greater.

A separate report was published that pertained to the effect of the varied diets on the duration of the instars. When the nymphs were supplied all the flies they can utilize in each and every instar, i.e. fed at a near-optimum rate, the five instars lasted the following average number of days: 7.40, 5.50, 5.60, 7.00 and 10.90 respectively, or a total of 36.40 days. These values, expressed in terms of the percent of time each instar represents in the entire

nymphal life, were: 20.35, 15.11, 15.38, 19.23 and 29.95, respectively. It will be seen that the first and fourth instars are equal in duration, as are also the second and third, while the fifth required as many days as the second and third combined. The data for 13 other series show that any instar may be attenuated to various degrees by reducing the diet. However, not all instars in the life of any one individual may be so prolonged. That is, the capacity to extend any instar decidedly beyond the usual length depends on the amount of food utilized in one or more previous instars. While the extreme of flexibility in duration was probably not demonstrated in this study, the ability to far exceed the usual duration is surprisingly great. For instance, one series of eleven low-fed individuals required an average of 138.19 days for the nymphal stage, and one female completed that stage in 185 days. It scarcely need be added that these starved bugs produced no eggs and had a brief adult life.

Economic Status.—This attempt to evaluate the economic status of *Phymata* was based on the 832 insects I had previously taken from the predator in the field. It lead to the deduction that *Phymata* is about as beneficial as destructive to our welfare. However, the principal merit of the undertaking was disclosure of the fact that determination of economic status is highly speculative and inconclusive. This is so because estimation of the economic importance of a predator, and particularly of one known to include 195 species of insect prey in its dietary, involves numerous variables and also much ignorance of the essential facts in the bionomics of the victimized species. Only a few instances need to be indicated to reveal the nature of these variables: (1) Differentials in the economic contributions made by the adults and the larvae of a prey species; in one stage, the victimized species may be beneficial as by pollination or through destruction of weeds, whereas in another stage it may be injurious; (2) a phytophagous stage may consume a variety of plants, some cultivated, some weeds; (3) the two or more generations which a prey species may have in a year can vary greatly in their importance owing to differences in the plant food, prey or hosts available to be attacked in each season; (4) the amount of harm or good performed by a species varies from year to year and from locality to locality; and finally, (5) one individual of a species may function in a friendly capacity, another in a destructive way, e. g. one bee pollenizes the flower of an apple, another a thistle. Estimates must therefore differ sharply from time to time and place to place, even granting that all the data were at hand for each situation.

Weight Pattern.—The discovery that ambush bugs obtained in the field varied greatly in weight prompted this inquiry into the amount, nature and causes of changes in weight during the lifetime of captive individuals. By weighing each daily throughout its nymphal and adult life, a body of data was secured which made possible the following characterization of the "weight pattern."

It was learned that the weight-growth curve of any one instar is essentially like that of any other when the individual is fed at the same relative rate throughout the nymphal life. This curve has the form of an attenuated capital S. The daily weights show that each instar exhibits two rather distinct phases, (1) a feeding-growing phase and (2) a molting phase. The first be-

gins when the new cuticle has set and the nymph resumes feeding, which activity had ceased with the inception of the second phase. In approximately the first three-fourths of the instar, feeding is intense, the intensity decreasing steadily however from day to day. As a consequence of such feeding, the weight rises sharply in the early days of the instar, some individuals displaying increases of 100 percent over the previous day. As the body seems to become saturated with wastes, feeding falls off and eventually ceases, with the result that the weight curve slopes off in the hours preceding the molt. Upon molting, the weight drops still more and sharply, the loss being approximately 10 percent of the pre-molt weight. Not less than 80 percent of this loss is traceable to the evaporation of fluids from the moist new cuticle, the rest to the exuviae. A state of comparative dessication is created by these losses, and it is apparent that this state stimulates the intensive feeding and sharp upswing of weight characteristic of the feeding-growing aspect of the instar.

The amount of increase in weight in any instar depends on the quantity of food ingested and on the sex of the bug, the females generally being heavier than the males. The average newly-hatched *Phymata* weighs about 0.0003 gram. At the end of the first instar, the average weight of 42 individuals had increased to 0.00094 gram, the extremes of variation being 0.0007 and 0.0014 gram. Corresponding values for the other four instars were: second, average, 0.0022, extremes, 0.0014 and 0.0040; third, 0.0065, 0.0041 and 0.0092; fourth, 0.0158, 0.0095 and 0.0231; fifth, 0.0317, 0.0193 and 0.0477 gram.

Investigators concerned with the phenomena of weight in the growing stages of insects have adopted the "growth quotient" as a convenient device to express the amount of net increase achieved in the several instars and the nymphal stage as a whole. The growth quotient is the value obtained by dividing the final weight by the initial weight irrespective of sex and diet. The quotients for the five successive instars of 28 individuals were thus: first, average 2.75, extremes 1.7 and 5.3; second, 2.62, -1.7 and 3.8; third, 2.46, -1.7 and 3.2; fourth, 2.49, -1.8 and 3.2; fifth, 2.1, -1.5 and 2.6. In the course of the entire nymphal life, the 28 individuals doubled their weights an average of 107.7 times, extremes 64.0 and 157.0. However, this great spread in extremes is reduced much when each sex is considered by itself. The males multiplied their weights an average of only 83.0 times as compared with 132.5 times for the females. The extremes for the males were 64.0 and 102.0, for the females 103.0 and 157.0. In other terms, the male nymphs gained an average of about 8000 percent, the females about 13,000 percent.

From their study of the Egyptian mantis, *Sphodromantis bioculata* Burm., Przibram and Megusar reported that the nymphs doubled their weight in each instar. This pattern of increase has come to be known as Przibram's principle of doubling. Reference to the average quotients cited above will show that *Phymata* did not conform to this principle, varying largely upward from it, the variations in the growth quotients depending on sex and the quantity of food provided. It is of interest also that the quotients secured from weights of the exuviae of well-fed *Phymata* correspond fairly well with those from the weights of the living nymphs already given.

Like the nymphs, the adults display weights that vary greatly with sex and diet. The males of all

dietary series varied from a low of 0.0185 gram to a high of 0.0391 gram, and the females from 0.0315 to 0.0628 gram. Almost without exception, the adult weighs least on its first day when it has suffered its extreme reduction due to recent molting and has not yet resumed feeding. The peak weight is attained at various time points in adulthood. If the nymph was under-fed, the adult lives only a few days and experiences its maximum weight on the day of molting or soon thereafter. Such adults are very short-lived. But the better- to optimally-fed adults achieve their maxima generally on or after the 10th day and may approach or reach the peak repeatedly afterwards. If fed at an adequate rate, the female maintains her maximum or near-maximum weight until the day of death. The principal factors causing fluctuations are ingestion and egestion, and, in the female, oögenesis and oviposition.

The weight pattern of well-fed adults embraces three fairly distinct phases, the first characterized by a slump in weight due to the losses peculiar to the final nymphal molt, the second by a sharp climb in weight that results from several days of intense feeding, and the third by its generally long horizontal plane interrupted by secondary ascents and descents arising from feeding, egestion, oögenesis and oviposition. Because the males feed less voraciously and the bulk of their sexual products is relatively minute their weight curve in the third phase is subject to a lesser degree of vertical fluctuation than that of the females.

How Much Food is Required to Grow a Bug?—The first step in the approach to this question was to determine how many *Drosophila* the nymphs sucked out in each of the five instars. Second, since it is impractical to weigh each fly just before and immediately after *Phymata* consumes its contents, I adopted an alternate method of securing the weight of substance the nymphs ingested. This method consisted simply of weighing (a) hundreds of whole living *Drosophila* and (b) hundreds of flies emptied of their contents by *Phymata,* whereupon the average weight of (b) was subtracted from the average of (a), the difference representing the bulk of food substance available in the average *Drosophila.* This value proved to be 0.0007643 gram. It was then multiplied by the number of *Drosophila* utilized, the product representing the approximate amount of food substance utilized by an individual in any instar.

In the following report of results, only the data from the third, fourth, and fifth instars are included, this for the reason that the small nymphs in the first two instars lack the capacity to ingest all the substance from a fly in one feeding. The relatively small amount required to complete these early instars was determined by estimation based on observations.

Several general theories are indicated by the data. First, the amount of food required by an individual to complete any instar or the whole nymphal stage is clearly affected by the rate at which food is supplied. To illustrate, each of eight bugs kept on a low diet ingested an average of 0.01290 gram while completing their fourth instar in 20 days, whereas each of 10 bugs kept on a more liberal diet consumed 0.04761 gram while completing the same instar in only 7.5 days. The data for the third and fifth instars and the whole nymphal life show this same kind of differences between low and more liberal diets.

Second, when the amount of raw food ingested is compared with the net increase in weight achieved in

any instar it is found that the major part of the food, or approximately three-fourths to four-fifths, is subsequently eliminated as gas, vapor or feces, probably largely the latter, and the remainder, or one-fourth to one-fifth, is converted into somewhat permanent bodily substance.

Third, the under-fed nymphs seem to utilize their food somewhat more efficiently than do the individuals supplied with an amount of food more nearly adequate to realize the innate vital potentialities of the species. That is, the proportion of wastes to permanent bodily structures is greater in well-fed than in low-fed nymphs. As an illustration, notethat eight bugs ingested 0.00727 gram in the course of their 9.0-day third instar: of this amount, an average of 73.15 per cent was expended, 26.85 percent converted into body. By contrast, 10 other bugs ingested 0.02063 gram during their third instar of 6.4 days: of this amount, 78.46 percent was eliminated, 21.54 per cent converted into body.

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THE ZOOPLANKTON OF CRAB ORCHARD LAKE DURING THE FIRST YEAR, 1941-1942

TROY C. DORRIS
Quincy College, Quincy, Illinois

Introduction

The dam at Crab Orchard Lake, east of Carbondale, Illinois, was first closed May 10, 1940, and completely filled February 1, 1942. W. B. Welch, of Southern Illinois University made periodic collections of the plankton from April 5, 1941 until April 3, 1942. He reported on the phytoplankton (Welch, 1942). Through his kindness, his collections were made available for the present study of the zooplankton. Thanks are due him for this and other favors and help, and to W. M. Gersbacher, of Southern Illinois University, for his advice and help.

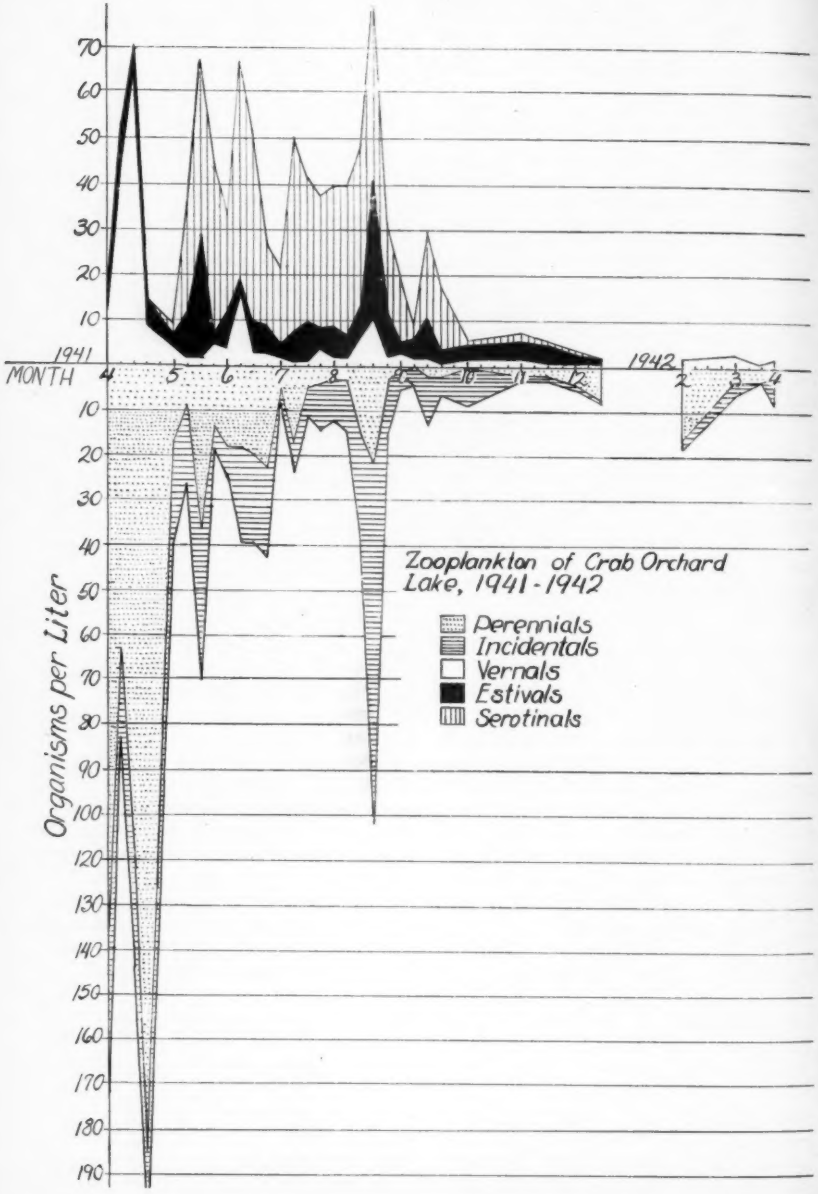
Fluctuations in Abundance

The great value of making frequent (weekly) collections during the spring, summer, and autumn is clearly shown in the accompanying graph. Several important fluctuations appear, which from their short duration could probably not have been discovered by collections at longer intervals. Notable fluctuations in abundance which occurred are described below.

(1) There was a great increase in numbers after the spring rains of 1941 had caused the surrounding lowlands to be flooded, and the subsequent aging of this new water. Large amounts of food materials were made available in the form of dead and decayed plants on the flooded lands. If the increase in numbers was actually caused by an increase of food supply, this organic debris must have been the source, since the plankton algae, which might have been a food source, showed no corresponding increase (Welch, 1942). Indeed, the only species of algae present in any quantity was a species of Asterionella. The other forms did not become abundant until later.

(2) A very sudden decline in population occurred after the early spring peak. This may have occurred as a result of the stagnation of the new water, and a decline in the amount of oxygen, or an increase in the amount of hydrogen sulfide, or a change in the pH. The decay of the organic debris in the water might have been the indirect cause of this decline through its effect on the factors mentioned. An examination of the data shows a very marked decrease in the numbers of individuals of most species in deep water after the first of June, when the general decline appears. It is probably in the deeper waters that a serious change in the factors mentioned would have had the most effect.

The increase and decrease described here are probably phenomena to be observed only in new lakes at the time of the first flooding, or other situations where a large amount of organic debris accumulates, as in lake bottoms which are exposed during long droughts. Eddy (1934) studied Lake Decatur in 1926, the second year after formation, and his graphs show no such increase or decrease, nor did it appear in the third or fourth years. There is no indication of


Zooplankton of Crab Orchard Lake, 1941-1942
Perennials
Incidentals
Vernals
Estivals
Serotinals
Organisms per Liter
MONTH
1941
1942

this change in the few data available for the second year at Crab Orchard Lake.

(3) There were two sharp increases in abundance in mid-spring and late spring. Both increases were immediately followed by sharp decline.

(4) Beginning about the first of July, the population increased and was held at a generally high level until about the middle of August.

(5) A midsummer increase in abundance occurred about the middle of August. This increase was more pronounced than either of those of the mid or late spring, but was shorter in duration. It is notable that this increase occurred in nearly all species on August 22.

(6) The increase of August 22 was followed by a very sharp decline, which continued into the winter with late fall and early winter populations at a low level.

Seasonal Development

The present study is of value in that it shows the trend of invasion and development from the first formation of the lake. Even in this early stage, seasonal and perennial predominants appear. In general, the data presented in this paper seem to correspond closely to the perennial and seasonal groups reported by Eddy. In some cases, however, there are differences. Where these differences occur, it is assumed for the present that such differences are a result of the immaturity of the successional development, and are not real. In Eddy's collections, some forms appeared earlier than others, and frequently had a different seasonal development in the early than in the later stages. Eddy's listing of perennial and seasonal predominants is adopted here, even though there are some apparent discrepancies.

Perennials

Difflugia spp. Eddy lists *D. lobostoma*, and *D. globulosa*, both of which are probably present here, but it was not possible to make a consistent separation. A species is present which appears to be *D. urceolata*—Protozoan
Polyarthra trigla Ehr.—Rotifer
Keratella cochlearis var *macracantha* (Gosse)—Rotifer
Synchaeta spp.—Rotifer
Bosmina longirostris (O. F. M.)—Cladoceran

Vernals

Notholca sp. (longispina Kellicott?)—Rotifer
Cyclops bicuspidatus Claus—Copepod
Cyclops spp.—Copepod

Estivals

Filinia sp.—Rotifer
Conochiloides sp.—Rotifer
Daphnia longispina (O. F. M.)—Cladoceran
Diaptomus spp.—Copepod

Serotinals

Pedalia mira (Hudson)—Rotifer
Diaphanosoma leuchtenbergianum Fischer—Cladoceran
Ceriodaphnia lacustris Birge—Cladoceran
Ceriodaphnia sp. May be *Moina* listed by Eddy—Cladoceran
Ceratium hirundinella O.F.M.—Protozoan

Incidentals

Cathypna sp.—Rotifer
Monostyla sp.—Rotifer
Ratulus spp.—Rotifer
Noteus quadricornis Ehr.—Rotifer
Chydorus sphaericus (O.F.M.)—Cladoceran
Nauplius—Copepod

Plankton Community Development

Eddy (1934) considers the only permanent freshwater communities to be found in streams. These communities reach the highest development in physiographically mature streams. Impounded waters, as in

the lake at Crab Orchard, duplicate the conditions of a mature stream to an extent that causes the plankton development to resemble that of a mature stream. This appears to be true at least in the earlier stages, but in later stages, the impounded lake resembles an abandoned stream channel. As such, it forms a developmental stage in a land community.

The newly formed lake probably represents a secondary bare area, since many of the later predominant organisms probably are present in the original stream. Upon the sudden increase of space, at flooding, with the attendant increase of available food materials in the submerged land vegetation, the zooplankton experiences a sudden rapid increase, as suggested by the data here presented. Later, conditions become stable at a lower level of productivity, and new forms invade until the typical stream community is developed.

Eddy suggested that fresh water communities may show an associational difference. He found species of Brachionus to be prevalent in the waters he studied in southern Wisconsin and northern and central Illinois, but lacking in southern waters. The data studied here seem to corroborate his suggestion, since species of Brachionus were very poorly represented for a short time in the summer only. However, the data are not extensive enough to warrant any further discussion here on that subject.

Summary

This study of the net zooplankton of Crab Orchard Lake during the first year of filling before overflowing the spillway found a list of 21 genera with at least as many or more species of zooplankters. Seasonal aspect is developed, with a hiemal society absent or poorly developed, a poorly defined estival society, and well developed vernal and serotinal societies. A possible indication of the associational nature of stream communities is shown in the absence or scarcity of species of Brachionus, which is a predominant organism in more northern waters.

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A MOSQUITO SURVEY OF LAKE BLOOMINGTON*

HAROLD D. MANUEL
Illinois State Normal University, Normal

A survey was started in September 1946 to determine the species of mosquitoes and their possible breeding places at Lake Bloomington, Bloomington, Illinois. Although only occasional visits were made between the months of January 1947 and May 1947, a thorough investigation was made during the fall and summer months of the year 1946-1947.

Adult and larval stations were established at fifteen locations around the lake which covered an area of about twenty square miles. Parts of this territory are used for summer camps, and many permanent shore camps and homes have been erected around the lake. The banks and nearby shores are wooded, but farming areas surround the lake beyond the wooded area. It is from the draining of these fields and two large streams, Money Creek and Hickory Creek, that the lake receives the greater portion of its water supply. Generally the stations chosen were small streams which were formed by drainage ditches and ponds which were formed by backwater of the lake. Two of the stations were located at the edge of the lake. Although these stations by no means exhausted all of the breeding places of such a large area, they were typical of all of the places where mosquitoes might be found. The wooded area was inspected for possible breeding places of tree-hole species of mosquitoes. Culverts, bridges, and buildings used as dwelling places for campers and visitors to the lake were inspected for adult mosquitoes.

Larvae and pupae were collected by dipping and were brought into the laboratory for identification and rearing. Larvae in the second and third instar stages and pupae were reared into adults. Fourth instar larvae were mounted and identified.

The purpose of the survey undertaken at Lake Bloomington was to establish what species of mosquitoes were present in that area. Collections were made to determine the relative annual abundance of the various species with information as to breeding places and the extent of the control of the problem.

The larvae of *Anopheles quadrimaculatus* Say and *Anopheles punctipennis* (Say) were found in slow moving fresh water. At some stations these larvae disappeared when the water in the pools became stagnant during the summer drought. This was believed due to the stagnation of the water because at the same inspection time larvae were found in moving water a short distance from the pool. Adults of *A. quadrimaculatus* were located abundantly in culverts near streams where the larvae were found. The adults were collected in larger numbers than the larvae of this species.

Anopheles punctipennis has a variety of feeding places but prefers margins of pools and streams and edges of the lake. This species was found breeding at seven of the fifteen stations inspected. Although in most cases the water was moving slowly where they were found, at two locations the water had become

* This is an excerpt from a thesis presented in partial fulfillment for degree of Master of Science in Education at Illinois State Normal University, Normal, Illinois. The author wishes to acknowledge the counsel of Dr. Donald T. Ries under whom this phase of the work was done.

stagnated. The larvae were feeding on the algae which grows in the streams and ponds. Although this species was found in greater numbers in the larval stages, the *A. quadrimaculatus* outnumbered this species in the adult collections. Other species which were found in the adult stage included *Anopheles barberi* Coquillet, *Culex pipiens* Linneaus, *Culex restuans* (Theobaldi), *Culex apicalis* Adams, *Culex salinarius* Coquillet, *Aedes vexans* (Neigen), and *Aedes canadensis* (Theobaldi).

Of the genus Culex the species *C. apicalis* was found in greater numbers both in the adult and larval stages. This genus was found breeding in much the same waters as the *Anophelines* but at stations where water seemed most stagnant the *Culicines* persisted while the *Anophelines* died out. The species *C. apicalis* was found abundantly in all the stations inspected both in the fall of the year and summer. The larvae were more abundant than the adults. *C. salinarius* were found in very small numbers. This species was found in grassy pools. The larvae of this species were found at one station. *C. restuans* was found in the fall of the year in a pool that was littered with decaying leaves.

Of the genus *Aedes, A. vexans* was found more abundantly than the other species. The principal breeding places were temporary ruts that had filled with rainfall and grassy lands that contained a temporary water supply. The larvae of *A. canadensis* were found rather sparsely in the fall of the year and only at one station in the spring. This was the earliest species collected in the larval stage. The spring of 1947 was unseasonably cold thus limiting the development of other species. During a warm period in April this species was found in a grassy area where pools had formed from recent rainfall. The pools were small, but many larvae were present.

There has been no attempt in this survey to make a complete study of the mosquito problem at Lake Bloomington, since there was insufficient time to apply to the many problems to be solved. Due to lateness in starting the problem, the survey is incomplete for the month of August and nearly so for the month of September; thus leaving without inspection, the two months in which the incidence of mosquitoes is highest. Tables were made giving a count of the relative abundance, and can be used as evidence of the predominance of different species. Only those which were brought into the laboratory for identification were recorded.

A list of the larvae collected in the order of their abundance:

Anopheles punctipennis
Culex apicalis
Aedes vexans
Anopheles quadrimaculatus
Aedes canadensis
Culex pipiens
Culex restuans
Culex salinarius

A list of the female and adult in order of their abundance:

Anopheles quadrimaculatus
Anopheles punctipennis
Culex apicalis
Anopheles barberi
Culex restuans
Culex pipiens
Culex salinarius

SEX AND THE ALTITUDE OF FLIGHT IN CYCLOCEPHALA

(Coleoptera: Scarabaeidae)[1]

GARLAND T. RIEGEL
University of Illinois, Urbana

Several years ago (1941) I published in these *Transactions* a short discussion of the two beetles, *Cyclocephala immaculata* (Oliv.)[2] and *C. borealis* Arrow, as they occurred one year at Urbana. I had found that these insects were attracted to light traps in the ratio of 10.3 females to 1 male. This was just the reverse of the situation reported by Neiswander (1938) in Ohio, who had worked with *borealis* and found that, over the season, 7 males appeared in his traps to 1 female. Unfortunately, neither paper gave the height of the light traps from the ground.

My traps were suspended from telephone poles over the tops of apple trees at a height of 10 to 12 feet. In correspondence Neiswander informed me that his traps had been operated at a height of about 5 feet, and although his traps were rather low, on occasion he did get more females than males in a single night's collection, but that the sex ratio in recent years would probably run even higher than 7 males to 1 female. It may be that the occasional preponderance of females at the lower levels is due to a weather factor, somewhat similar to that observed by Wellington (1944) in the case of *Culex*.

Also in 1941 there appeared the study by Johnson of his work in Connecticut with *C. borealis*. Johnson, who stated that his traps were placed directly on the ground, found that the ratio of the sexes was 272.6 males to 1 female. He gave a description of the mating habits of the beetles, pointing out that mating takes place at dusk or at night, on or near the ground shortly after emergence from the soil. Hayes (1918) in describing the mating of *immaculata* said that it "takes place in the daytime [dusk?], and in life-history cages was several times observed on the surface of the soil." Ritcher (1944) has stated that the life cycle and biology of the two species are similar.

M. W. Sanderson made light trap collections at Fayetteville, Arkansas, in 1940, 1941 and 1942. His trap was hung between 7 and 8 feet high. He kept a record of all *Cyclocephala*, males and females separately, that were taken each night. The species of *Cyclocephala* collected was *immaculata* (with a very few *robusta* Lec.). In 1940 he operated the trap from June 19 to August 29 and took *Cyclocephala* between June 19 and August 17. In 1941, the only complete season Dr. Sanderson operated the trap, the operating dates were from April 11 to October 31 inclusive and *Cyclocephala* appeared from June 6 to October 1. During 1942 the trap was on from April 4 to August 28, and the beetles were taken between June 8 and August 19. In 1940 the sex ratio was 4.96

[1] Contributions from the Entomological Laboratories of the University of Illinois, No. 284. Published by permission of the Graduate College. I wish to thank M. W. Sanderson, Illinois Natural History Survey, for generous permission to use his unpublished data, and W. R. Horsfall, University of Illinois, for various suggestions.

[2] It appears that it may be necessary to call this species *C. tenuicutis* (Casey), as the true *immaculata* is said to be confined to the West Indies (see Arrow, 1947).

males to 1 female, in 1941 it was 3.01 males to 1 female, and in 1942 the ratio was 2.37 males to 1 female. Only the ratio for the complete season of 1941 is shown in the tabulation below.

When considered in relation to the elevation of the traps from the ground, these apparently divergent observations on the sex ratio of *Cyclocephala* in four localities indicate that there is a flight stratification of the sexes.

Thus we have a nice correlation between the height of the light trap and the ratio of males to females taken:

Place	Trap above ground (in feet)	Ratio of sexes		
		Males		Females
Conn.....	1	272	to	1
Ohio.....	5	7	to	1
Ark.....	7-8	3	to	1
Ill.....	10-12	1	to	10

It seems from what we know of the habits of these insects that the males begin emerging from the soil in advance of the females. Mating takes place as soon as the females appear near, at, or just above the surface of the ground. It may be that the males ordinarily restrict their flight to within a few feet of the ground in their search for the females, as Johnson (*op. cit.*) has reported that the males "usually fly from 1 to 2 feet above the ground," and also that the males seem more active in the mating behavior. After mating it may be that the females become more active and fly higher in a sort of dispersal flight. As the adults are believed not to feed, it could hardly be a flight to find food. I have checked many of the females taken at the 10-12 foot level, and all were found to be carrying eggs.

It is quite apparent that there is the likelihood of misleading results in the use of light traps for checking on the difference between sexes in altitude of flight where the species is strongly attracted to artificial light. We do not know that the two sexes are attracted equally. Hayes (1925) has noted that, in a related subfamily, the males of *Phyllophaga* are commonly considered to be more abundant at lights than the females. In his study this was found to be true in 19 species, while in 3 species the females were more common at lights than the males. Further, if the sexes were equally attracted to lights, and if there was a stratification in the flight of the sexes, the influence of light traps would upset the stratification to a greater or lesser extent. On the other hand we cannot ignore the distinct differences between these four *Cyclocephala* studies which were based on hundreds of specimens trapped.

We know little about how far these beetles can be attracted by a light. It may be only a short distance, and they may come into the effective range of the light in a hit or miss manner during a somewhat aimless flight.

To summarize, on the basis of four studies involving the use of light traps, there is evidence that (1) male *Cyclocephala* beetles tend to remain near the ground, while (2) the females tend to fly at a higher level, and (3) are probably not attracted to artificial light until some time after mating.

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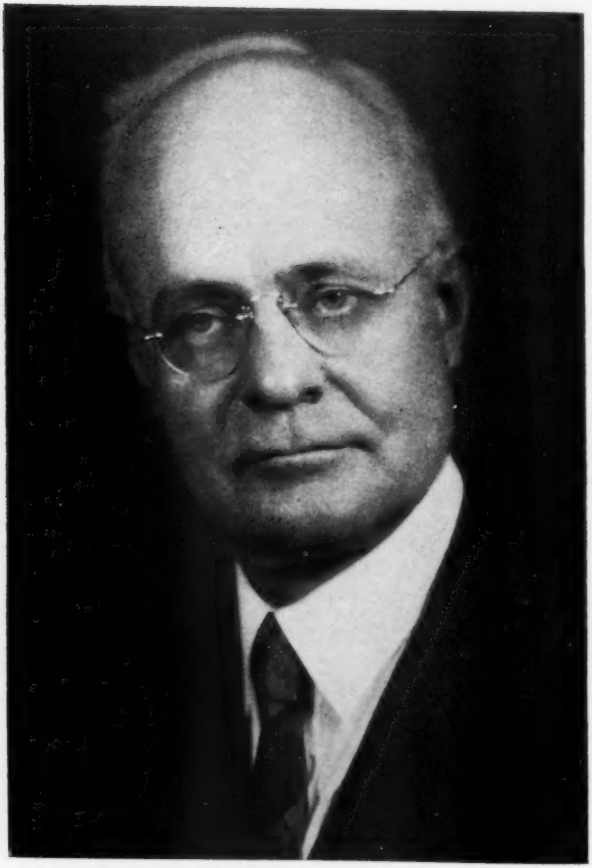
ERRATA

"Additional Records of Illinois Mammals," R. M. Wetzel, Trans. Illinois State Acad. Sci. 40:228-233, 1947:

Lines 21 and 22, page 232, right hand column, under *Neotoma floridana illinoensis* Howell. Illinois Wood Rat, which read "*Alexander*—Horseshoe Lake (Olive Branch), 1 INHS." should read "*Union*—Wolf Lake, 1 (skin only INHS)."



CLARENCE BONNELL
1863-1947

MEMORIALS

CLARENCE BONNELL
1863-1947

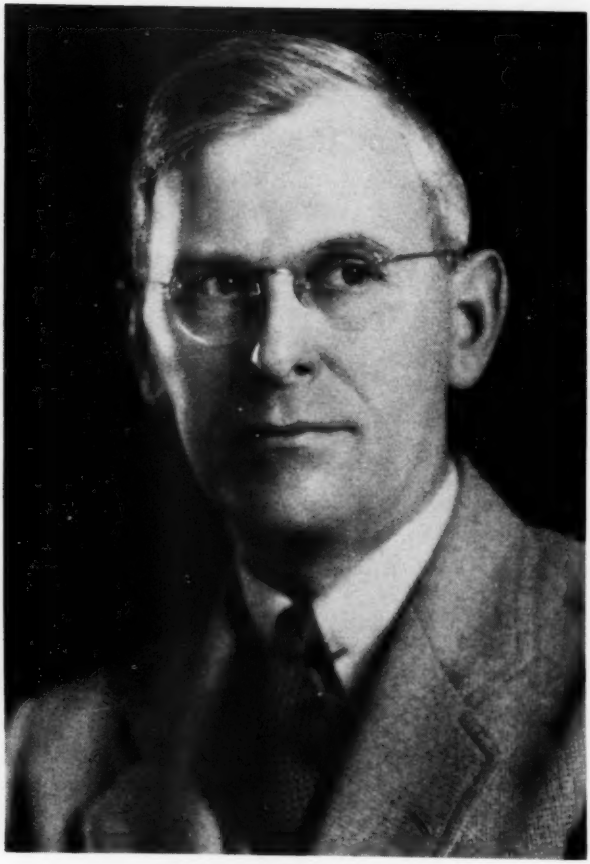
Clarence Bonnell, educator, naturalist, and author, was a native of Christian County, Illinois, and died June 21, 1947 at the age of 74 in Del Rio, Texas, of a heart attack while enroute home from the Rotary International Convention at Los Angeles.

Mr. Bonnell was for 43 years the assistant principal and head of the science department of the high school at Harrisburg, Illinois. He was president of the Salina County Historical Society, was a director of the Southern Illinois Historical Society, and a member of the Illinois State Academy of Science of which he was a past president. He was on the Board of Directors of the Friends of Our Native Landscape, 1927-30. He was also author of two books, "Little Journeys from Harrisburg," and "The Illinois Ozarks."

He was active in promoting State Parks in the southern part of Illinois and one of his greatest civic achievements was the long-time planning of a township park at Harrisburg which was built in an area made worthless as residential property by the subsidence of worked-out coal mines. This area, through his foresight, has been converted into a modern park with lagoons in the sunken areas and landscaped according to his proposals.

A son, Dr. Ellis Bonnell, of San Francisco, a psychiatrist who served as a medical officer overseas in World War II, and a daughter, Miss Mildred Bonnell, a food economist, who has just served with the UNRRA for two years in China, survive.

GEORGE D. FULLER



TERENCE THOMAS QUIRKE
1886-1947

TERENCE THOMAS QUIRKE

1886-1947

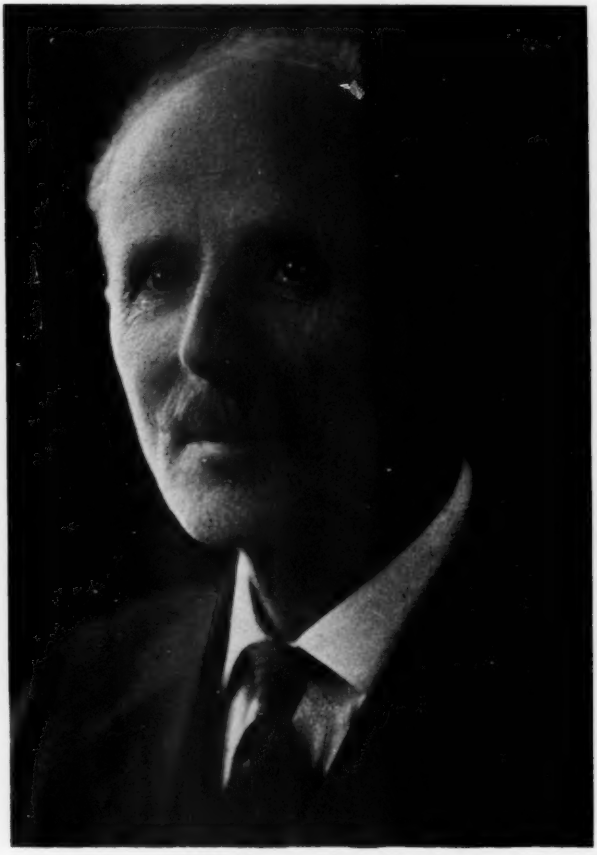
Terence Thomas Quirke was born at Brighton, Sussex, England on July 23, 1886. After secondary school training at Bancroft School, he came to the United States as a youth of 17 and attended the University of North Dakota where he graduated in mining engineering in 1912. He did graduate work at the University of Chicago, serving as research assistant to Professor R. D. Salisbury and completing work for the doctorate degree in 1915. While at Chicago Quirke started summer field work on the pre-Cambrian rocks of the Canadian shield for the Geological Survey of Canada, and continued in this field of research until 1931. Upon receiving his degree he accepted a position at the University of Minnesota, teaching structural, economic and field geology. In 1919 he was brought to the University of Illinois as chairman of the department of geology. He continued at Illinois until his death, serving as departmental chairman until 1928. His teaching covered engineering geology and mineralogy, petrology, structural and economic geology.

His Canadian research led to the discovery that the Huronian metamorphosed sediments north of Lake Huron seemed to grade eastward into granites which had been called Laurentian and considered much older than the Huronian. This discovery not only altered the correlation which had been made within the Canadian shield but it also suggested that large masses of granite may form by a process of granitization of pre-existing rocks. This concept has had much additional support in recent years and "the origin of granite" was the subject of a full day symposium before the Geological Society of America last Christmas. Other noteworthy contributions by Quirke were the developmen of an ingenious device for projecting optic figures, and researches in various titanium compounds. After the Geological Survey of Canada discontinued the employment of other than Canadian citizens in 1931, he took part in numerous investigations of mineral prospects in Canada, Vermont, Cuba and the southeastern United States. He was the author of 34 books, bulletins, journal articles and geologic maps.

He joined the Illinois Academy of Science in 1921, and presented five papers before the geology section at various meetings. He was chairman of the geology section in 1944-46 and a member of the research development committee. In addition he belonged to several other professional geological and engineering societies.

Quirke will be remembered for his great contributions to pre-Cambrian geology, for his interesting lectures, and for the high ethical standards which he impressed on the generations of young men students who came under his direction. He was active until the day of his death, having taught classes in the morning and attended a Rotary Club luncheon at noon that day, August 19, 1947.

HAROLD R. WANLESS



THOMAS EDMUND SAVAGE
1866-1947

THOMAS EDMUND SAVAGE
1866-1947

Thomas Edmund Savage was born on a farm near Salem, Iowa, in 1866. His education included attendance at Whittier College, Iowa Wesleyan College, and the University of Iowa, where he received his bachelor's degree in 1897 and master's in 1899. He received the doctorate in geology from Yale in 1909.

He served as high school principal at Mt. Pleasant, Iowa from 1895 to 1896, and was professor of biology and geology at Western College from 1899 to 1903. He joined the staff of the Iowa Geological Survey in 1903, where he served as Assistant State Geologist until 1906. He came to the University of Illinois in 1906 as a member of the department of geology and for many years combined his teaching career with summer work on the Illinois Geological Survey which had been reactivated in 1905, only one year before Savage's arrival in Illinois.

Savage's field of research was the sedimentary rocks of the Paleozoic era and the life record revealed by their contained fossils. He concentrated especially on the rocks and faunas of the Silurian and Devonian periods, but also worked extensively on the Pennsylvanian. His classification of the Silurian and Devonian rocks of Illinois and their correlation with other areas has been the standard for the Mississippi Valley for many years. Although his field work was largely in the Mississippi Valley, one notable exception was his study of the rocks along the shores of Hudson and James Bays, Canada, in 1916.

In addition to his special stratigraphic and faunal studies Savage left a great monument to his career in reports on the areal geology of several counties in Iowa and at least ten quadrangles in Illinois with an aggregate area of nearly 2000 square miles.

Savage joined the Illinois State Academy of Science during its first year and regularly participated in its programs for many years starting with the second annual meeting. Altogether he appeared on the programs of 15 annual meetings. He was chairman of the geology section in 1931. He was also a member of many other professional geological societies and during his life published 69 papers.

For 28 years of active service he taught courses in historical geology, paleontology and stratigraphy at the University of Illinois. Many of his students now occupy prominent places in the geological profession. During his later years he became interested in the geologists' view of evolution and the relation between the evolutionary doctrine and religious faith. He believed that the acceptance of evolution was possible along with the retention of firm Christian faith and gave addresses and wrote articles on this theme. After his retirement in 1934 he was spared for 13 additional years during which his health permitted travel, community activity and geologic research. After a brief illness he died November 22, 1947.

He will be remembered as a kindly and scholarly teacher and as one who contributed much to unravelling the complex threads of the earth's past history.

HAROLD R. WANLESS

JOHN VOSS
1895-1948

JOHN VOSS

1895-1948

With the passing of John Voss, Peoria lost a beloved teacher and a good citizen, and Illinois lost a keen and hard working scientist. He was born in Peoria on December 24, 1895, and died at his home on March 20, 1948 after an illness of several months.

His early education was in the public schools of Peoria and in the Bradley Institute, and afterwards at Knox College, Galesburg, where he was graduated with the Degree of B. S. After teaching in Elgin, Roseville, and Arlington Heights, and serving for a short time in World War I, he returned to his native city and to its Manual Training High School where he taught biology and mathematics from 1924 to 1934.

He was appointed principal of Washington School in 1935, and in 1937 he became the principal of the Manual Training High School where he served until his fatal illness in 1947. Under his administration numerous improvements were made in this school.

Continuing his formal education, largely during his summer vacations, he entered the University of Chicago where he received the degrees of M. S. in 1925, and Ph.D. in 1933.

John Voss was a charter member of the Peoria Academy of Science, and gave it outstanding service from its organization in 1930. He served as Vice President, President, and as Director, and was elected to an honorary membership on February 10, 1948.

He was a member of the Illinois State Academy of Science from 1928 and was a regular attendant at its meetings. He served as Treasurer from 1937 to 1947.

As a scientist John Voss has made outstanding contributions to the past history of the vegetation of Illinois during the Yarmouth, Sangamon, and Early Wisconsin interglacial periods as revealed by his studies of the fossil pollen of the peat deposits in the state.

A thoroughly trained plant ecologist, John Voss carried his scientific spirit into his hobbies. He was a skillful photographer, and his flower photographs of the local flora have brought distinction to his community, and honorary mention in a national competition. He was a Fellow of the A.A.A.S, belonged to the Ecological Society of America, the Botanical Society of America, the Torrey Botanical Club, and was also a member of Sigma Xi.

John Voss will be remembered by his hundreds of students as a beloved teacher, by his acquaintances as a dependable friend, and by his fellow scientists for his modesty and his untiring pursuit of truth.

Dr. Voss is survived by his widow, Marie, a son Eugene J. Voss of Peoria, two grand daughters, and two brothers, Henry and Fred of Peoria.

GEORGE D. FULLER

ISABEL S. SMITH

1864-1948

Isabel S. Smith was born at Hillsdale, Michigan, on October 22, 1864, and died at Oberlin, Ohio on January 19, 1948.

After some years of teaching in high schools in Ohio, she became an Assistant in Botany at Oberlin College from which institution she was graduated with the degree of A. B. in 1901. In 1903 she went to Illinois College at Jacksonville, Illinois where she remained for 24 years, advancing from the rank of Instructor in Biology to that of Professor of Botany and Dean of Women. During her stay at Illinois College she found time for further study at the University of Chicago from which institution she was granted the degrees of M. S. in 1905 and of Ph. D. in 1922.

She was a charter member of the Illinois State Academy of Science in 1907 and soon became a life member. She was Vice-President of the Academy in 1919. She was also a member of the Botanical Society of America.

Upon her retirement from teaching at Illinois College in 1927, she made her home at Oberlin, Ohio, where she was made assistant Curator of the Herbarium of Oberlin College, an activity that she maintained for many years.

She was an efficient teacher, a close friend of all her students and a botanist who knew the plant life of the community in which she lived.

GEORGE D. FULLER

ACADEMY BUSINESS

SECRETARY'S REPORT ON THE BUSINESS OF THE ILLINOIS STATE ACADEMY OF SCIENCE

FOR THE YEAR MAY 3, 1947 TO MAY 8, 1948

Compiled by HURST H. SHOEMAKER, *Secretary*

The loss to the academy in the death of Dr. John Voss, Treasurer, on March 20, 1948 was great. Dr. W. W. Grimm, who had so generously assisted in the work during the illness of Dr. Voss, was appointed to serve out his term of office.

The academy held its 41st annual meeting in Benton on May 7 and 8. There were 134 papers presented in the 10 senior and 2 collegiate sections to a record attendance of 500 persons. The annual banquet speaker on Friday evening was Kenneth A. Reid, Executive Director of the Izaak Walton League, who spoke on "Land and Water Management in the Public Interest." Eugene S. Richardson, Jr., of the Chicago Natural History Museum, spoke Friday afternoon before 350 Junior Academy members on "Major Features of Earth Structure." On Saturday more than 100 persons took part in biological, geological, industrial, and archaeological field trips.

1. COUNCIL MEETINGS

There were four council meetings during the year. At the first meeting, May 3, 1947 in Peoria, Illinois, Clarence Bonnell's invitation to hold the next annual meeting in Harrisburg was accepted. Because of Mr. Bonnell's death during the summer, the question of a meeting place was re-opened.

At the second meeting in Urbana, October 25, 1947, with President Stover presiding the council accepted an invitation extended by Mr. B. Floyd Smith to hold the annual meeting in Benton. Dr. Neil Stevens and Editor Rose presented reasons why the publications committee was unable to carry out the council's decision at Peoria to print in the Transactions abstracts of papers not accepted for full publication. As a substitute, for this year, the council voted to print brief abstracts of all papers in this year's program. When it was learned how much higher the printing costs would be than anticipated, a quick poll of the available council members was taken and a substitution was made. This was to suggest that chairmen of each section mimeograph the abstracts and distribute them at the annual meeting. Because of the general increase in prices and the fact that our dues had remained at the original one dollar for 40 years, the council voted to circulate the membership on the question of an increase in dues.

President Stover called the third council meeting which met in Urbana, January 17, 1948. The meeting was devoted largely to plans for the annual meeting. Dr. Mills offered the services of the Natural History Survey in conducting the biological field trips. The council unanimously voted to sponsor the recordings of the "Science on the Air" programs which they hoped would be financed by the University Extension.

President Stover presided at the fourth council meeting held in Benton, May 6, 1948. The council approved the ranking of the papers for publication by the sections and left the method of ranking to the section chairman. The council unanimously passed a motion to combine the committee on science talent search selection with the committee on science talent search scholarships. Consideration was given to the appointment of a permanent publicity chairman, but action was deferred. A motion was passed that the Council recommend an increase in annual dues to $2.00 to be voted on at the business meeting the following day.

2. GENERAL BUSINESS MEETING

A short preliminary business meeting was held at 9:30 a. m., May 7, 1948, at which appointments were made to committees on nominations, resolutions, auditing, and necrology. At the second business meeting held at 5:00 p. m., reports were heard from the acting treasurer, the editor, and chairmen of the committees on auditing, conservation, resolutions, necrology, and nominations. It was announced that Knox College, at Galesburg had invited the Academy to hold its next annual meeting there.

REPORT OF TREASURER

For the Year May 1, 1947 to April 30, 1948

Receipts

Balance on hand April 30, 1947		$ 1,537.69
Dues and initiation fees:		
Annual members	$ 725.00	
Life member	25.00	
Affiliated societies	11.00	
		761.00
Interest on Forbes and Meyer real estate		18.00
Interest from U. S. Savings Bonds		5.00
Sale of Transactions		3.10
Sale of reprints		97.65
Libraries		7.00
Research Grant by the A. A. A. S.		408.00
Junior Academy:		
Dues	$ 1.00	
Sustaining memberships	10.00	
		11.00
Total Receipts		$ 2,848.44

Expenditures

Council dinner and breakfast—Peoria	$ 67.00
Local Chairman's expenses—Peoria	66.53
Section Chairmen's expenses	12.60
Treasurer's office expenses	14.50
Secretary's office expenses	4.17
Editor's expenses	17.00
Librarian's expenses	59.80
Transporting Transactions—2 years	9.35
Corporation registration	1.00
Conservation Council	3.00
Printing	228.25
Secretary, honorarium	125.00
Editor, honorarium	150.00
Research grants—C. W. Bennett, $75.00; W. M. Reid, $75.00; H. F. Thut, $50.00; Sr. M. Joan, $83.00; P. E. Martin, $125.00	408.00
Flowers for Dr. John Voss	10.85
Junior Academy	83.38
Total Expenditures	$ 1,260.43
Less Outstanding Checks	423.57
	$ 836.86
Balance in Commercial Bank of Peoria	2,011.58
	$ 2,848.44

Statement of Resources, April 30, 1948

Balance in the Commercial Bank of Peoria	$ 2,011.58
Certificate of interest for Meyer Block Leasehold	Value Unknown
Certificate of interest for Forbes Building	Value Unknown
United States Savings Bonds, Series G	200.00
Total Resources	$ 2,211.58

The membership of the Academy consists of 61 life members, 97 new annual members, 17 sustaining members, 509 members paid up to and including the year 1948, 214 members one year in arrears, 42 members two years in arrears. The total membership is 843. During the year 14 members have resigned, 4 were deceased and 35 moved, leaving no forwarding address.

Respectfully submitted,
JOHN VOSS, Treasurer (deceased)
W. W. GRIMM, ad interim Treasurer

REPORT OF THE COMMITTEE ON AUDITING

To the Illinois State Academy of Science:

Your committee on auditing respectfully submits the following report:

We have examined the records of the Treasurer, John Voss, and the ad interim Treasurer, W. W. Grimm, for the year May 1, 1947 to April 30, 1948, and find them correct. The present financial status of the Academy is as follows:

Cash on deposit with the Commercial National Bank of Peoria	$ 2,011.58
Series G, U. S. Savings bonds two	200.00
Meyer Block Leasehold Certificate No. 15 (value unknown)	0.00
Forbes Building Certificate No. 13 (value unknown)	0.00
Assets	$ 2,211.58
Less outstanding checks	423.57
Real Assets	$ 1,788.01

(Signed) A. G. ADAMSON, Chairman
E. SCHOENBECK
L. P. ELLIOTT

REPORT OF COMMITTEE ON RESEARCH GRANTS

Following is a list of projects approved by the Committee on Research Grants:

William M. Bailey Southern Illinois University, 506 S. Popular, Carbondale, Ill.	$ 60.50
Bernard Greenberg Roosevelt, Chicago 5, Ill.	25.00
J. V. Karabinos St. Procopius College, Lisle, Ill.	45.00
R. Maurice Myers Western Illinois State College, Macomb, Ill.	40.00
James M. Sanders Chicago Teachers College, 6800 Stewart Ave., Chicago 21, Ill.	45.00
Sister M. Christine Mundelein College, Chicago 40, Ill.	45.00
Total	$ 260.50

(Signed) J. W. NECKERS,
Acting Chairman,
Research Grants Committee

REPORT OF COMMITTEE ON RESOLUTIONS

RESOLUTION No. 1

WHEREAS the Illinois State Museum is performing a valuable educational function both by its instructive exhibits in its present location, and also by numerous loan exhibits circulated through the schools of the state; and

WHEREAS it is obvious that the present quarters of the museum are excessively cramped, inconveniently located, and altogether inadequate for the proper performance of its useful purposes; and

WHEREAS the Illinois State Legislature has already appropriated funds for the acquisition of a site for an adequate museum building, and for the preparation of suitable plans for such a building; and

WHEREAS the plans now drawn up for the new building have received wide praise from museum people over the nation, and the execution of these plans would provide the citizens of Illinois with what would probably be the most effective, though not the most costly, state museum in the country;

THEREFORE, the Illinois State Academy of Science reaffirms its approval and

support of this museum building project, and resolves to take such steps as seem appropriate, to acquaint the governor of the state and other executive and legislative officers, that would be in position to cooperate, of its conviction that they will serve the best interests of the state by appropriating adequate funds at an early date for the erection of the proposed museum building.

Resolution No. 2

Whereas, the State of Illinois is known to contain small natural areas distinct and precious by reason of their unique ecological features and rare species of plants and animals, and

Whereas, these areas are too small for inclusion in the State Park System as now visualized, and

Whereas, these areas are threatened with impairment or destruction by the inroads of industry, agriculture or other developments, therefore

Be It Resolved, that the Council of the Illinois Academy of Science refer to the proper committee of the Academy the question of (1) finding some administrative state agency interested in the acquisition of such widely separated areas, (2) proposing some way of administering and protecting them, and (3) devising some method of selecting deserving sites, formulating specifications which the sites should meet, and assuring that the purpose for which the sites are set aside be actually preserved.

Resolution No. 3

The Illinois State Academy of Science, at its annual business meeting held at Benton, Illinois, May 7, 1948, voted to favor the establishment of a permanent nonpartisan Conservation Commission of the State of Illinois.

Resolution No. 4

The Illinois State Academy of Science is pleased hereby to express its appreciation to the Benton Chamber of Commerce, the Board of Education, the Superintendent of Schools, Mr. B. Floyd Smith and his committee on local arrangements, the Benton Baptist Church, and to any other persons or groups who served in any way to provide housing, meeting places, projecting equipment, excellent musical entertainment, direction and transportation on field trips, and other services and equipment necessary to the happiness of members and visitors and to the success of the annual meeting of the Academy held at Benton, Illinois, May 7 and 8, 1948.

Resolution No. 5

Resolved, that the Secretary of the Illinois State Academy of Science write a letter of appreciation to Mrs. John Voss, Mrs. Ethel Schoenbeck, and Dr. Wilbur W. Grimm, all of Peoria, Illinois, for their valuable assistance to Dr. John Voss in the management of his work as treasurer of the Academy during his illness in the past year, 1947-1948.

Resolution No. 6

Resolved, that the Secretary of the Illinois State Academy of Science is hereby directed to write a letter to Mr. Robert Ingli, Director of Visual-Aids, Southern Illinois University, Carbondale, Illinois, expressing the appreciation of the Academy for his indispensable services in providing and setting up projectional equipment required in the presentation of lectures and papers at the annual meeting of the Academy held at Benton, Illinois, May 7, 1948.